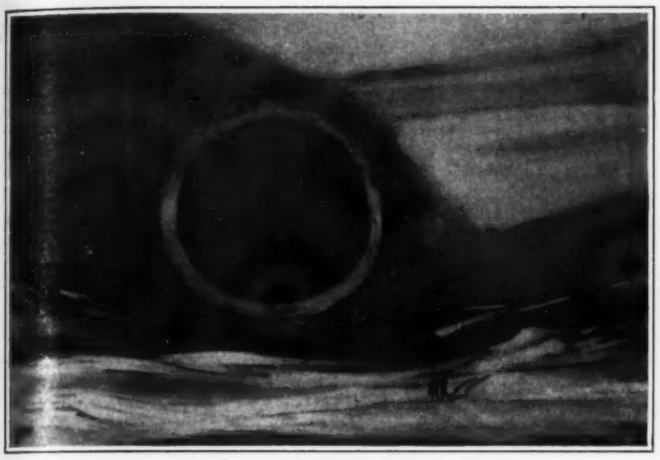
SCIENTIFIC AMERICAN SUPPLEMENT

Copyright 1914 by Munn & Co., Inc.

VOLUME LXXVII]
NUMBER 1991

NEW YORK, FEBRUARY 28, 1914

[10 CENTS A COPY
$5.00 A YEAR



Fog-bow.

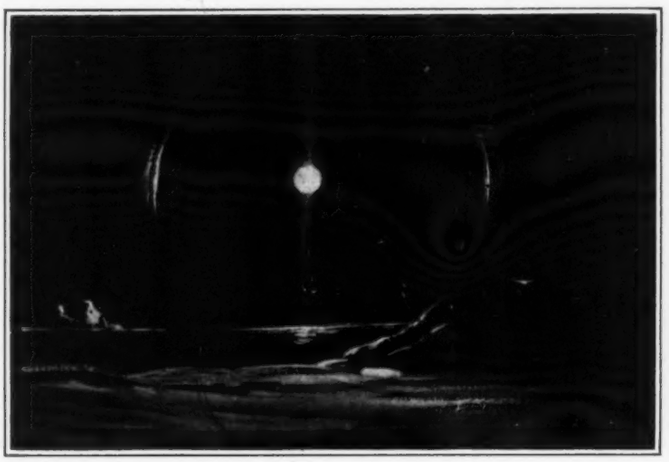
Fogs composed of water-drops occur even at temperatures far below freezing, and give rise to the "white rainbow." Ice-fogs produce a similar phenomenon known as "Bouguer's halo." The small angular diameter of the phenomenon here shown is anomalous.

A singular variety of "earth-shadows."

A case of this kind, in which the shadows were thrown entirely across the sky from mountains behind the observer, is described and figured in Shackleton's "Heart of the Antarctic," vol. II, p. 378.

A curious low-sun effect.

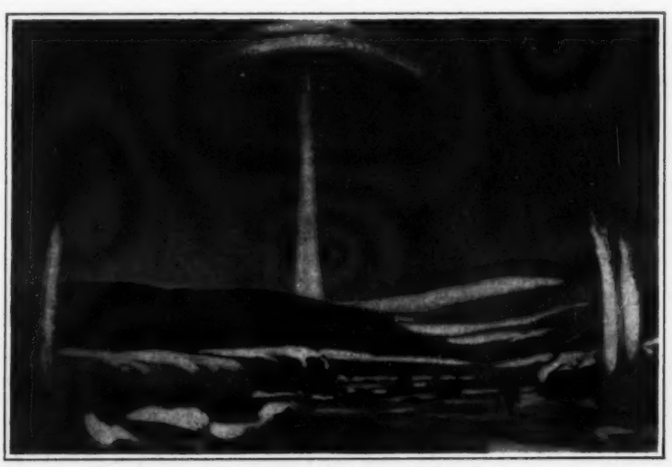
Strange distortions of the solar image near the horizon are commonly seen in the polar regions.



Lunar halo, with moon-pillar.

The angular diameter of the lunar disk is evidently shown much too great in proportion to radius of the halo.

Crepuscular rays and mirage.



Sun-pillar and 22-degree halo.

OPTICAL MARVELS IN THE ANTARCTIC.—[See page 132.]

The Life of Building Power Plants*

An Important Question for Investors

By C. M. Ripley

In April, 1913, Mr. W. H. Chesebrough, president of the Alliance Realty Company, asked the author the following question: "How long can a private electric plant be run before it has to be replaced?" It was an original and searching question, and one which sought for *facts*. Others have asked frequently how much depreciation should be charged off on engineering installations of various kinds. This question desired no one's conclusions—merely the facts in the case.

The electrical profession is in such infancy that up to the present time we have had very few data on the subject of the life of electric plants in buildings. It has been the custom of many engineers and architects to assume a 5 per cent depreciation as the proper annual charge-off on such installations. It has been the opinion of eminent men who have examined the facts developed by Mr. Chesebrough's question, that 5 per cent depreciation has been used temporarily in the absence of better data, that it has been only guesswork, that it must now be upset as incorrect, and that preconstruction methods of figuring must be revolutionized.

OLDEST PRIVATE ELECTRIC PLANT IN NEW YORK.

It is an interesting fact that the oldest plant for generating electricity in a building in New York city was installed and in operation less than four years after Thos. A. Edison announced his discovery of the incandescent electric light in October, 1879. In 1883, Mr. George B. Post let the contract for a private electric plant in the Mills Building, opposite the Stock Exchange on Broad Street, New York city. This was before there were trolley cars in New York city. This plant is still in daily operation. It seems miraculous that the fifteenth and nineteenth dynamos made by Thomas Edison have run every day for over 31 years and are still in perfectly serviceable condition. Not only are the same dynamos in operation but the original engines installed at the same time by the New York Safety Steam Engine Company, long since out of business, are the sole means of driving the dynamos. A year later, another unit of exactly the same type and capacity was added. Mr. A. M. Bogart, the chief engineer of the building, states that these machines operate daily until the load becomes too large for them to handle it. This time is between 4:00 and 7:00 A. M. every day.

As an example of how the erection of high buildings in the neighborhood has increased the need of electric light in the Mills Building, it should be noted that the owners installed at later dates, a 75, a 100 and a 160 kilowatt dynamo to carry the increase thus made necessary. The three original dynamos were each of 25 kilowatt capacity, showing that the new equipment was used to supplement, and not replace the older and smaller apparatus. Regulation of the height of buildings will make entirely unnecessary such additions to future electric plants.

Mr. Bogart calls attention to the further fact that even though these engines and dynamos may be assumed to have a lower efficiency than more modern apparatus, he must heat the building during a large part of the year; thus he explains the fact that these engines are used. Had machines of higher efficiency been installed, the exhaust steam from them would not have been sufficient to heat the building, and live steam from the boilers would have to be used in larger quantities than is required even now on cold days to supplement the exhaust from these old engines.

Mr. George B. Post is responsible for the oldest electric plant in New York city, if not in America or in the world. Thus did he and Thomas A. Edison link their talents, and "builded better than they knew." This adds one more triumph to his record of original achievements, which include the installation of the first passenger elevator in an office building, the compilation of the first tables of moments of inertia of steel beams, the design of the first building over 12 stories in height, the idea of hanging scaffolds from openings in the building rather than building them up from the ground on the outside, and besides he was the first to order floor arches to be installed as the steel work rose.

At this point the question raised by Mr. Whitaker, editor of *The Journal of the American Institute of Architecture*, may be introduced. He asked: "Why not figure out for each of the old plants what would have been the proper rate of depreciation to have charged off from the start?" In order to carry out this important suggestion, a report was obtained from a certified public accountant, which is included here because of its brevity and clearness:

*Read before the American Society of Heating and Ventilating Engineers.

TIME REQUIRED FOR A SINKING FUND TO EQUAL ORIGINAL INVESTMENT

(Sinking fund earning 4½ per cent interest, compounded annually)

Percentage Depreciation Charged off Annually		Years Required to Refund Investment
1½	Between	31 and 32
2	Between	26 and 27
2½	Between	23 and 24
3	Between	20 and 21
3½	Between	18 and 19
4	Between	17 and 18
4½	Between	15 and 16
5	Between	14 and 15

It is proper and conservative to assume the above rate of interest on a sinking fund.

OTHER PLANTS OF HISTORICAL INTEREST IN NEW YORK.

On the basis of the figures quoted in the foregoing, it will be seen that in the following plants the annual depreciation has been less that 2 per cent.

In the Dakota Apartments, H. J. Hardenbergh installed a private electric plant in 1885. Some of the same apparatus is still running every day. One direct connected unit was added afterward because of increased load due partly to the erection of large buildings on either side. This plant also supplies a dozen or so private residences on 72nd and 73rd Streets with heat and electricity. The machines were Edison dynamos also. Another plant in its 29th year of service is in the Wells Building, in which the New York Quotation Company has a private plant supplying electricity to 1,200 tickers below Fulton Street. The Osborne Apartment house contains an old belted Edison dynamo held in reserve. This machine is 29 years old.

By referring to the figures quoted by the accountant, it will be seen that the annual depreciation in the following plants is less than 2½ per cent.

The Evelyn Apartment house has a 25-year-old plant which consists of one engine and dynamo which run every day from late afternoon till 1:30 o'clock A. M. The Bank of New York has an old outfit 25 years old, which is held as a reserve, but is run once a week to keep it in good condition. The Union Trust Company, for 25 years past, has had its same engines and dynamos running, and at present they operate from 8:00 o'clock A. M. to 10 P. M. The Tower Building, soon to be razed, has a plant 24 years old which has the record of running as long as the building has stood.

For 24 years, the electric dynamo at 79 Crosby Street has supplied electricity to the building, and now supplies two other buildings. Madison Square Garden has a private plant that is now idle after working 23 years. The superintendent claims that during the past summer he has saved money by shutting down the plant in May. Those in charge say they can run the plant if they want to, as that provision was made in the electric contract. The Nevada Apartments still obtain their electricity from the old belted plant that has been under the sidewalk for 23 years. This plant has never been enlarged, as the building occupies the entire flatiron block and tall buildings could not be built adjacent. The Mechanics and Metals Bank operated a plant for about 23 years and abandoned it. Shortly after, the building was torn down to make room for the new Morgan Building.

Attention might also be called to the following plants which have been in operation sufficiently long to warrant placing the annual depreciation at less than 3 per cent:

Delmonico's, also on a flatiron corner at Beaver Street, still obtain their electricity from the same old engine and dynamo that have served them for 22 years. The same is true of the Butler Brothers store on Broadway; no change in 22 years. The same is true of the United Charities Building, which also supplies next door. The Evening Mail Building has a plant now reported to be in its twentieth year of service.

The Potter Building plant has seen 19 years of service and is still running. Thus the annual depreciation of its plant is less than 3½ per cent.

Mr. Hardenbergh's Waldorf Astoria has a plant in perfect condition after 17 years, and the owners of the Bennett Building state that their plant is now in its eighteenth year. In these two, the annual depreciation has therefore been less than 4 per cent.

The Sterling Building on East 17th Street has had one engine and one dynamo for 17 years; no other. Mr. C. C. Mailloux, an electrical engineer, reports the unique and successful installation of a gas engine, dynamo and storage battery in St. Paul's Methodist Church which has run continuously for 16 years. The engine operates three days per week and the battery furnishes lights during the rest of the week. It will thus be seen that in these two buildings, the annual depreciation is less than 4½ per cent.

INTERESTING BUT NOT CONCLUSIVE.

The foregoing are only a few of the many plants which were inspected during the search for the oldest plant in New York. The data are interesting and historically instructive, but no logical conclusion can be drawn therefrom for the reason that the plants which were failures are not to be found. Possibly someone may say the foregoing plants were selected and are even exceptional cases. In order to answer Mr. Chesebrough's question, all the dead plants must be reported on as well as the survivors.

A HUMAN ANALOGY.

If it were desired to know "the life of a man" it would require the combined records of all the insurance companies and the life work of an investigator. But it is comparatively simple to determine the life of the men in some well-known American families, as records are in existence of the lives of the members of those families.

The only records open to the investigator who included those plants which *are* running as well as those which *may* have been scrapped, are the records of the office with which he is identified. Thus all the plants "fathered" by this office of consulting engineers comprise a class in which an exhaustive investigation may be conducted with profit and which may lead to important conclusions. A personal inspection was therefore made of every private electric plant in New York city and Jersey City, which had been designed and constructed under the supervision of this certain engineering office. All plants mentioned hereinafter are therefore in either one of these two cities. The records referred to cover a period of 22 years or from 1892 until 1914. All dates and ages have been given accordingly.

The records of private electric plants to which the investigator had access, show the following now in operation, on which a 5 per cent depreciation appears to have proved excessive. The four following are in their 22nd year of service:

The New York Eye and Ear Infirmary runs its plant 18 hours daily and the rest of the time on a storage battery. It later added to its building, and installed an additional engine and dynamo, and the storage battery. Jacob Ringle & Son use an old engine which supplies belted power as well as electricity. The Havemeyer Building, which later added a larger dynamo owing to the erection of tall buildings next door and opposite on Church Street and on Cortlandt Street, and owing also to the increased use of electricity. The New York *Herald* Building, in which no new engines have been added, as the building occupies an entire flatiron block and no building could be erected adjacent. The dynamos now in service are not the ones originally installed, but the old engines are. This may be considered an exception. However, the chief engineer claims his plant is 42 years old, as with *The Herald* and *The Telegram*, both daily newspapers, it has done double duty.

Therefore it seems, on the basis of the table furnished by the certified public accountant, that the foregoing plants show less than a 3 per cent depreciation with the possible exception of *The Herald* plant. If these plants operate for another year 2½ per cent depreciation will appear to have been proved excessive.

PLANT IN TWENTY-FIRST YEAR OF SERVICE.

The Presbyterian Building has neither added to nor subtracted from its original electric plant, and since it is still operating in perfect condition a 3 per cent depreciation has been proved excessive.

PLANTS IN TWENTIETH YEAR OF SERVICE.

The St. Paul Building has made no change in its electric plant. This, according to history, was the first 25-story building ever erected. Both the manufacturer of the engines and the dynamos are long since out of business but their product survives them.

The New York Clearing House has made no change in its electric plant. It obtained an advantageous rate for street steam and holds its boilers in reserve. Grace Chapel has run the same plant for all these years without change. The Liederkranz Club has its original engines and dynamos. The plant runs afternoons and evenings, the storage battery serving the lights during the rest of the time. In all of the foregoing plants 3½ per cent depreciation may be considered as excessive.

PLANTS IN NINETEENTH YEAR OF SERVICE.

The American Surety Building now operates the same engines and dynamos as were originally installed. These were shut down for two years, but in 1913 were started

up. The Metropolitan Building (Havemeyer Estate) and the Commercial Building (Havemeyer Estate) have been in operation without change since originally installed. The Criminal Courts Building is operating its original plant. It later added one other cheap engine and dynamo which are but little used. In the old *Times* Building one of the original engines and dynamos are still in service. St. Luke's Hospital operates every day between 11:00 o'clock P. M. and 8:30 A. M. its old engines and dynamos. Additions to the hospital necessitated installation of other units. In all of these plants 3½ per cent depreciation, to all appearances, has been proved excessive.

PLANTS IN EIGHTEENTH YEAR OF SERVICE.

The Polhemus Memorial Clinic Dispensary has a plant which has been taken better care of than any of the other plants inspected in connection with compiling these data. The Mechanics Bank of Brooklyn still retains its same old apparatus, operating it daily. In these two plants 4 per cent depreciation seems to have been proved excessive.

PLANTS IN SEVENTEENTH YEAR OF SERVICE.

The Empire Building has made no changes in its electric plant since first installed. The Germania Bank Building, the smallest office building with a plant, and the smallest plant in New York city, has a plant now operating in its seventeenth year. The building is 6 stories, 60 feet by 102 feet, with 2 electric elevators. The New York Athletic Club has still the same engines and dynamos. This plant is operated on a yearly contract covering heat and electricity. The contractor paid for 2 new boilers. In the Vincent Building, National Bank of Commerce, and O'Neill's Department Store there have been no changes in the plants. The Terrace Garden plant was in a precarious condition when inspected, owing to lack of proper maintenance. The tenant is spending close to $10,000 per year for electricity from the street, it is said, but will not appropriate half this amount for improvements. His lease will expire shortly. The Church of the Holy Trinity has made no changes in the plant serving the boys' club, gymnasium, church house, parsonage, etc. In the foregoing plants all in their seventeenth year of service 4½ per cent depreciation has been proved excessive.

PLANTS IN SIXTEENTH YEAR OF SERVICE.

The Ormonde and Seminole apartments are operating the same equipment as originally installed. These were among the first apartments to give refrigeration service to tenants. The Sprague or Anderson Building and the Metropolitan Museum of Art are operating the original equipment. For 15 years the one engine and dynamo served the old Astor Library. When the Astor Library was removed to the New York Public Library Building, the director, the late Dr. J. S. Billings, and others in authority, voted that the old plant be carefully removed and installed ready for service in the new building. The plant, speaking sentimentally, has been pensioned as its reward for faithful service for a period of nearly 16 years. It is still capable of useful work. For experimental purposes this may be operated later, or for periods of light load, or it may be sold and used elsewhere. In any case, it cannot be said that the plant is dead—just retired—perhaps only temporarily but certainly with credit. In the foregoing plants 4½ per cent depreciation has apparently been proved excessive.

PLANTS IN FIFTEENTH YEAR OF SERVICE.

The Navarre Hotel operates the same old apparatus, and also supplies several stores next door with heat and electricity. The building at 395 Broadway still operates the plant as originally installed. The Wellington Hotel has retained its original plant and the Commercial Trust Company, Jersey City, operates its original apparatus. The plant in the New York University (Hall of Fame, etc., University Heights), consisting of but a single engine and dynamo, supplies light and power to 6 buildings, and heat to 12 buildings covering 37 acres. The plant is heavily overloaded. In these plants, all doing their fifteenth year of service, 5 per cent depreciation, to all appearances, has been proved excessive.

The foregoing list of 34 private electric plants are all in operation, except the Library pensioner. This list covers every installation made in 1909 and earlier, by the office with which the author is identified. No plants installed in 1900, or before, have been scrapped, but during the current year some of these plants mentioned herein may be discontinued and sold for scrap. Within the year, the Stock Exchange and Blair buildings will probably enter the lists to tend to disprove further the necessity of a 5 per cent depreciation charge. It would impose needlessly on your time to note the younger plants installed at later dates than those in the foregoing lists, provided they are in daily operation. It is necessary however, to refer to such later or younger installations which may have succumbed to the vicissitudes of active power plant life in a greater or lesser degree. In this class there is one idle plant, namely, the Ward Line Building, 34 feet by 100 feet, 9 stories in height, still contains the plant installed in 1901 and operated between 9 and 10 years. This plant is now idle, but through change of policy on the part of the owner or by sale to some outside party, it may yet see many years more of service. The data are insufficient to determine the percentage of depreciation.

SUMMARY OF PROBABILITIES (OR CERTAINTIES).

In no private electric plants investigated has the real depreciation been determined. The investigation covered the whole of the subject; i. e., every plant designed by the consulting engineering office referred to.

Taking into consideration private electric plants (*installed as early as* 1900), the results stand as follows:

34 show less than 5 per cent depreciation.
29 show less than 4½ per cent depreciation.
17 show less than 4 per cent depreciation.
16 show less than 3½ per cent depreciation.
4 show less than 3 per cent depreciation.

1 (*New York Herald*) plant may or may not show less than 3 per cent depreciation.

SUMMARY OF POSSIBILITIES.

Among the oldest survivors installed before the establishment of this engineering office, accompanied by an unknown number of "dead" plants, are the following:

16 show less than 3 per cent depreciation.
12 show less than 2½ per cent depreciation.
4 show less than 2 per cent depreciation.
1 shows less than 1½ per cent depreciation.

Giraffe's and How They Are Hunted

For a long time our discriminating ancestors declined to believe in the giraffe. It was too much for their credulity; and not unreasonably, for what Thomas Hood called "the great anti-climax"—

So very lofty in the front,
So dwindling at the tail.

is, in truth, an improbable beast. People who cheerfully accepted the basilisk and cockatrice and unicorn drew the line at so demonstrably mythical a thing as the giraffe.

Great, then, was the sensation when in 1827 the Pasha of Egypt sent four living camelopards as presents to Constantinople, Venice, England and France respectively. The English one was sickly and soon died, but that accredited to Paris achieved such an instantaneous success as might have aroused the jealousy of Chantecler himself, for "men and women," we are told, "wore gowns and gloves and waistcoats of the color of its spots." Nine years later the Zoological Society succeeded, through the agency of M. Thibaut, in getting safely to London four giraffes, which were escorted hither with much ceremoniousness and under the ægis of the Admirality itself. Of all large mammals, the giraffe takes, perhaps, most kindly to captivity, living to a good age and breeding freely in confinement, so that some 19 fawns in all have been born in Regent's Park since those four came here in 1836. In the spring of 1892, however, the last two members of the old strain died, and then again for ten years, chiefly because the Mahdi had made importation inconvenient from the Soudan, London was giraffeless. With the five which are in the Gardens now, two of which are males and three females, there is every reason to hope that the breed will be maintained for another long period, even though the giraffe seems never to have more than one young at a time.

ITS LACK OF FIGHTING QUALITY.

It is to be hoped that the stock may be long successfully maintained, for the time may come when its continuance will be a matter of the greatest urgency. The "proud camelopard" is a creature ill fitted to survive in the struggle against civilization, and the period seems to be already in sight when, except in zoological gardens or in large preserves, it may well become extinct. The giraffe is not a fighter; and lions and leopards prey upon it, though probably not as often as they would like to do, for even to human palates the meat of a cow giraffe is extremely good.

HOW THEY ARE HUNTED.

One method of hunting giraffes is to stalk them till within, if possible, a couple of hundred yards or so; and then, when you are discovered, to put your horses at them at top speed, "rushing" them as hard as may be. While, if you let the giraffe take its own pace, it will, with its queer lop-sided gait, tire the stoutest horse, it is, on the other hand, easily "hustled" and may be run down in the course of a mile or two. So completely do they lose heart when pushed that cases have been known of the animals, when hotly pursued, dropping dead, seemingly from mere distress. Before the invention of modern weapons, it used to be necessary to get to very close quarters (to "board" your game, Sir Cornwallis Harris calls it) and shoot with the gun held almost touching the beast's side; for the giraffe is blest with a hide so thick that it has been much sought after by some native tribes for the making of shields and by Boers for the manufacture of sjamboks. This hide offered so much resistance to the old-time bullet that it took Sir Cornwallis Harris 17 shots to bring down his first giraffe. As curious is the tale of Mr. Selous of how he rode a giraffe. When hunting with a friend he had wounded one of the giants, which sank to its knees and did not rise when the hunters came up with it:

"I'll bet you, you won't get on its back," said my friend. We were both of us very young men then, which perhaps does not excuse the thoughtless cruelty of the act; but in answer to my friend's challenge I at once vaulted on the giraffe's back and sat astride it just behind the withers. Immediately I touched it the startled animal struggled to its feet and started off at a gallop. Clasping it round the neck I had no difficulty in maintaining my seat, and my remembrance is that the motion of my tall steed was easy. . . . After carrying me for a short distance at a swinging canter the giraffe once more knelt gently down and I hastily dismounted.

THEIR BEAUTY.

But, except under stress of necessity and for their meat, the killing of giraffes is but a sorry business, in spite of all that those who have experienced it can say of the exhilaration of the reckless ride, through thornbushes and over ant-bear holes, at the heels of the flying beasts. Every one who has seen them in their wild state speaks of a troop of giraffes as one of the most beautiful things in the world. "I have never seen a more impressive sight," says Sir Harry Johnston; "a marvelous sight," exclaims Sir Cornwallis Harris, and "one of the most wonderful things in nature," testifies Mr. Bryden, while Gordon Cumming tells how—

"My senses were so absorbed by the wondrous and beautiful sight before me that I rode along like one entranced . . . with sensations different from anything that I had experienced during a long shooting career.

Even in captivity, the individual animals are singularly beautiful, both in their coloring and in the gracious stateliness of their movements, as well as, not least, for their wonderful eyes, from which one can well believe that, as M. Thibaut asserts, they have been known to shed tears when separated from their companions. It seems to add something to its patient dignity that the giraffe is, alone so far as is known among all mammals, voiceless. It seems to make no sound of pleasure, of warning, of fear, or of pain. It affords practically no "trophy" to the hunter except its tail; and to kill so beautiful and so great a thing, as it is too often killed, either for killing's sake or in order that its hide may be made into whips, seems almost one of the most wanton cruelties of civilization.—*The Times* (*London*).

Alloy Steel for Locomotive Parts

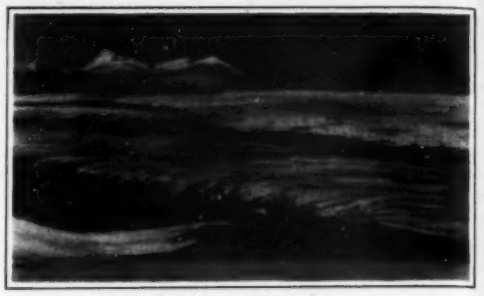
THE use of alloy steel, properly heat treated, for locomotive parts has been attended with much success. In addition to those parts where the steel is used for its effect in giving greater reliability or improved wearing quality, such as frames, springs, axles, and tires, it is also used for other parts where, indirectly, it permits of a large increase in the capacity of passenger locomotives. This result, states the *Railway Gazette*, arises from the fact that the permissible weight that can be placed upon the coupled wheels depends very largely on the weight of the excess counterbalance that is included to balance the reciprocating parts, and therefore by lightening these parts and reducing the excess it is possible to use an increased static weight on the driving wheels. This, in turn, means that the boiler can be very materially enlarged, and thus the capacity of the locomotive as a whole increased. Alloy steel, properly heat treated, when combined with careful designing, will accomplish much in reducing the weight of the reciprocating parts, and the net result of the reduction with one type of locomotive was that a deadweight considerably in advance of that previously possible could be placed on each axle with entire safety. At 70 miles per hour, with this locomotive, the dynamic augment of the excess counterbalance is less than 30 per cent of the deadweight on the driving wheels, and even then the locomotive will not impose as great a stress on the track nor do as much damage to itself as is experienced with most engines which have a considerably less weight on each driving axle.—*The Engineer.*

Number of Automobiles in the United States.—There are now some 1,127,940 automobiles in use in the United States, according to a careful compilation by the Secretary of New York State, though the figure does not include California, from which State returns were not available. As might have been expected, New York leads with a total of 133,000 registrations, a gain of 51,000 since 1911. Illinois is next with 95,000, and Ohio third with 87,000; Pennsylvania is fourth with 79,000, and Iowa fifth with 77,000. Nevada, on the other hand, has the least, the number of cars being but 1,141, with Wyoming next (1,585) and New Mexico next with 1,972.

Sastrugi (snow-dunes).

Optical Marvels in the Antarctic

Light-Pillars, Coronas, Auroras and Mirages That Greet the Southern Explorer



A dangerous crevasse.

THERE is hardly a narrative of arctic or antarctic exploration that does not tell of striking, weird, beautiful optical phenomena; halos, parhelia, fogbows, mirage, and what-not. There is hardly one of these narratives, the scientific value of which would not have been vastly enhanced if the narrator had possessed a competent knowledge of atmospheric optics before undertaking his polar journey. The descriptions are generally vague; accurate measurements are lacking; the altitude of the luminous source (sun or moon) is not stated; and so on. Nearly always the writers ignore absolutely the established terminology of photometeors. As often as not, awkward circumlocutory descriptions of the phenomena are substituted for their names. As once pointed out editorially in the SCIENTIFIC AMERICAN, this is very much as if a traveler, on returning from a visit to the Sahara, should mention having seen "a large, brown quadruped with a hump on its back," instead of saving words and avoiding ambiguity by recording that he had seen a camel. Every known optical phenomenon of the atmosphere has a scientific name. There are halos of definite radii (22 degrees, 46 degrees, etc.); upper and lower (and other) tangent arcs; the parhelic circle; parhelia; paranthelia; the anthelion; the arcs of Lowitz; light-pillars; coronas (including Bishop's ring); primary, secondary, supernumerary, and intersecting rainbows; superior, inferior and lateral mirage; and scores of other phenomena, all duly described, discussed, and *named* in such works as those of Bravais, Pernter, Besson and Mascart.

When Scott's first antarctic expedition went south, an elaborate book of instructions, the "Antarctic Manual," was printed for its guidance in making scientific observations. In this book, optical phenomena were ignored. A few such phenomena were skillfully drawn by the lamented Dr. E. A. Wilson, but they were not satisfactorily described. This expedition brought back the first pictures of "earth-shadows," such as are shown in one of the illustrations which we present herewith; i. e., the shadows of hills or mountains projected by a low sun on an atmosphere apparently clear but really charged with fine ice-crystals.

Mr. George Marston, whose drawings accompany this article, was the artist of Shackleton's first expedition, and is to accompany the explorer on his new venture in a similar capacity. Mr. Marston is an able draftsman, but does not profess to be a physicist or a meteorologist, nor is it to be expected that the artist of a scientific expedition should possess an expert knowledge of all the various sciences that enter into its programme. He should therefore not be blamed for the fact that the beautiful picture of a lunar halo (viz., fragments of the 22d degree halo and the lunar cross) which he contributed to Shackleton's book, "The Heart of the Antarctic," is mislabeled "A paraselene," or that similar misapplications of the terms "paraselene" and "parhelion" occur in connection with some of his drawings which have appeared in other publications.

Scott's last antarctic expedition was fortunate in having on its staff a meteorologist of rare ability in the person of Dr. George C. Simpson. On his return to civilization, Simpson described and discussed his observations of certain optical phenomena, and brought to bear on the subject a sound knowledge of the scientific questions involved. Simpson's memoir, published in the *Quarterly Journal* of the Royal Meteorological Society for October, 1912, demonstrates that even at a temperature as low as 21 degrees below zero Fahr., antarctic fogs are commonly composed of water, not ice; and that the fogbow seen in high latitudes is, therefore, at least in some cases, a "white rainbow," and not a halo. Simpson also demonstrates pretty conclusively that all the coronas which he saw in the Antarctic were due to water-drops, rather than ice-needles; and, incidentally, that true ice-clouds probably never give rise to coronas. He adds: "This is an important question for meteorology, for if it is true we have a powerful instrument for determining the constitution of a cloud; if there is a corona, the cloud must be composed of water, while if there is a halo it must be composed of ice."

However, the circumpolar regions also furnish the ideal conditions for the formation of complicated and beautiful halos, for a still air charged with ice-crystals is of frequent occurrence. In temperate latitudes such phenomena, on the rare occasions when they are seen, are ordinarily due to refractions and reflections of light in a distant cloud; while in high latitudes the halo-producing crystals may be in the immediate vicinity of the observer. Greely records a case of a brilliant parhelion, or sun-dog, seen projected against the wall of his meteorological observatory only 30 yards away.

The theory of halos can never be fully elucidated without thorough investigations of the various forms assumed by ice-crystals in the atmosphere, and such studies should form part of the programme of all polar expeditions. One of the few examples of excellent work in this field is that of Dobrowolski, of the "Belgica" expedition. This observer made numerous drawings through the microscope of snow and frost crystals, but unfortunately had no facilities for photographing them. His drawings and descriptions have enabled Dr. Louis Besson to make some important amendments in our views concerning several interesting halo phenomena. Dr. Alfred Wegener, who crossed Greenland with Capt. Koch's expedition, in 1912, is understood to have secured many microphotographs of snow-crystals, but his observations have not yet been published.

Nowhere else are seen so many remarkable forms of mirage as in the polar regions. Those drawn and described nearly a century ago by Scoresby are famous. The following extract from Scoresby's classic narrative bears a striking resemblance to the few accounts we possess of the fata morgana, as seen over the Straits of Messina:

"The general telescopic appearance of the coast (of Greenland) was that of an extensive ancient city, abounding with the ruins of castles, obelisks, churches, and monuments, with other large and conspicuous buildings. Some of the hills seemed to be surmounted by turrets, battlements, spires and pinnacles; while others, subjected to one or two reflections, exhibited large masses of rock, apparently suspended in the air, at a considerable elevation above the actual termination of the mountains to which they referred. The whole exhibition was a grand and interesting phantasmagoria."

In modern times the most remarkable pictures of arctic mirages have been those obtained by the camera. A wealth of such photographs will be found in Dr. Wegener's contributions to the reports of the Danish Greenland expedition of 1906–08.[1])

[1] Danmark-Ekspeditionen til Grolands Nordostkyst, 1906–1908. Bind II. Nr. 4. Meteorologische Terminbeobachtungen am Danmarks-Havn, von Alfred Wegener. Kobenhavn, 1911.

The Stability of Aeroplanes

IN these days of aerial gymnastics, or "stunts," as they would be termed in America, the question of the righting possibilities of an aeroplane has additional interest over that which it possessed when pilots were less venturesome. In the early days of modern aeronautics the idea that many of the simpler phenomena were capable of logical explanation was laughed to scorn. The new development, with a few exceptions, had got into the wrong hands. At that time Prof. Bryan was working these matters out mathematically. He was severely criticised by men who represented the actual aviators, and who refused to believe that the complications met with in practice were capable of rational analysis. Prof. Bryan started with the simpler problems, but subsequent work has carried the matter much further, and Mr. L. Bairstow, in a paper read before the Aeronautical Society of Great Britain, gave a demonstration of the value of this kind of work in practical aeronautics. Mr. Bairstow's paper was entitled, "The Stability of Aeroplanes," and he stated that by means of analytical treatment, on Prof. Bryan's or Mr. Lanchester's methods, aeroplanes can be produced either inherently stable or having unstable characteristics of any particular kind. The author described a stable aeroplane as one capable of recovering its correct flying position and speed when the pilot left it to choose its own course, provided sufficient height from the ground were available. The question of self-correction might be divided into two parts—namely, that dealing with machines of inherently stable design and that of machines provided with some mechanism providing automatic stability. It was then demonstrated that a properly-designed aeroplane, provided, in addition to the supporting surfaces, with vertical fins above the planes, would recover its normal flying position whether launched upside down or sideways. It was possible to take into account, in the mathematical treatment, the question of gusts, which was merely analogous to side-slipping, which the analysis allowed for. A stable machine must turn into the wind, and as the stability increased this movement would become rapid, perhaps to the discomfort of the pilot. Longitudinal stability was of three kinds. The first, "catastrophic instability," had been treated by Mr. Lanchester in his paper before the last meeting of the British Association. The second was due to rapid oscillations, in which the tail and head tilted alternately up and down. These usually died down, but in extreme cases might cause the aeroplane to turn over and over. The third class, known as phugoid oscillations, caused the aeroplane to move in a vertically wavy path of oscillations of long periods—about twenty seconds. This effect could be reduced by using a sufficiently large tail-plane and elevator. If the tail were not large enough, the amplitude of the wave would increase and end in a too sharp descent. These points were well illustrated by mica models of planes with and without tails and fins. Longitudinal stability could be easily attained by alteration of the tail-plane. It was associated with the principle of the upward vee, in which the forward plane was more heavily loaded than the rear. Lateral stability was more difficult to secure. If a model with a vertical tail fin rolled, the tail turned the machine into the wind. Rolling might also be set up which might result in a progressive increase of the tilt until the aeroplane took a steep spiral path, from which it could not recover. Such instability arose from the use of too large a rudder. The proportioning of the rudder and vertical fin system was one of the most difficult problems. If a machine were spirally unstable, it might be remedied by deepening the body forward of the center of gravity or by increasing the dihedral angle with other corresponding changes. The author suggested that a machine should be made partly inherently stable, the rest being provided by control, with the ability to cut the inherent stability out when necessary, as, for instance, in flying in gusty weather or landing in a confined area.—*Engineering.*

PRACTICALLY all the energy requirements of the surface and elevated railway companies of Chicago are now supplied by the Commonwealth Edison Company. Recently three of the old elevated railway generating stations have been taken over by the central station company—the Fullerton Avenue station of the North-Western Elevated Railroad Company, the Loomis Street station of the Metropolitan West Side Elevated Railway Company and the Fortieth Street Station of the South Side Elevated Railroad Company. It is probable that eventually all of the railway generating stations will be shut down, although some of them, notably the South Side Company's station, have an excellent record of economy. Five railway sub-stations also have been taken over by the sub-station department of the Commonwealth Company. The highest total output maximum of the Commonwealth Edison Company up to November 1st, 1913, was 257,830 kilowatts. This occurred on October 31st, 1913. The highest peak of last Winter was 232,950 kilowatts on December 11th, 1912. It is estimated that this Winter's total output maximum will be about 300,000 kilowatts. The highest 24-hour kilowatt hour output up to November 1st of last year was 3,365,900 kilowatt-hours, and was recorded on October 30th, 1913. It is probable that this Winter it will be 3,700,000 or more.—*The Engineer.*

Bites of Venomous Serpents and Their Treatment

Wherever Serum is Employed the Mortality Has Become Almost Zero

Dr. R. Burnier

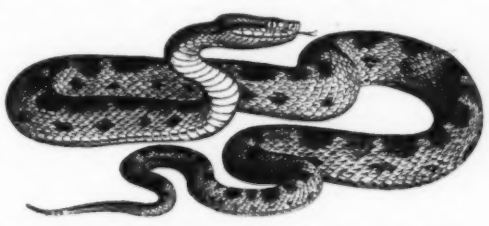
THE principal venomous serpents of France are two vipers (*Vipera herus* and *V. aspis*), which, though less formidable than their tropical congeners, annually kill a few persons and wound many others. Only a few years ago, from 30 to 40 per cent of viper bites proved mortal, but now Dr. Calmette's researches have furnished a cure which is absolutely certain, if it is promptly applied.

The treatment is an outgrowth of Calmette's study of the toxic properties of serpent venom, which vary in different serpents. There are two great families of venomous serpents: the *Colubridae*, with fluted poison fangs, represented by the East Indian cobra; and the *Viperidae*, with perforated fangs, represented by the European viper and the American rattlesnake. All serpent venoms, but especially those of *Viperidae*, contain a proteolytic ferment which liquefies gelatin, albumen and fibrin, and which is destroyed by heating to 158 deg. Fahr. All venoms also possess power to dissolve the red and white corpuscles of the blood, and this hemolytic property requires for its destruction heating to 212 deg. Fahr. for half an hour. Serpent venoms contain, in addition, numerous toxins, called cytolysins and bacteriolysins, which destroy microbes, protozoa, and the cells of the liver, kidneys and other organs, more or less rapidly.

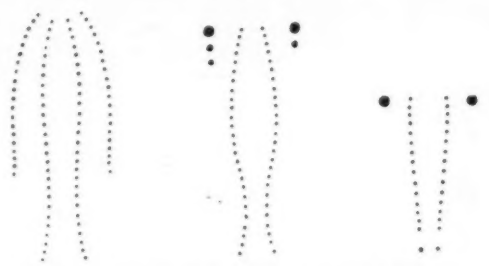
But the most important poisons in serpent venom, those which cause death, are two in number. One is a poison to the nervous system, called neurotoxin, which, according to Calmette, inhibits the respiratory centers and causes death by suffocation. The other poison, hemorrhagin, first coagulates, then redissolves the blood and destroys the walls of the blood-vessels, besides producing severe local inflammation. All serpent venoms contain both neurotoxin and hemorrhagin, but in varying proportions, neurotoxin predominating in *Colubridae*, and hemorrhagin in *Viperidae*.

These facts explain the differences in the effects produced by the bites of serpents of different species. In a person who has been bitten by a cobra, the most conspicuous symptoms are of nervous character. There is very little local pain, little or no swelling, but the patient soon experiences a sort of lassitude and an irresistible desire to sleep. His respiration becomes labored, his pulse slow and weak, until he falls into coma and dies. In some cases, the heart continues to beat two hours after respiration has ceased. The whole tragedy occupies only a short time, rarely exceeding six hours.

The bite of a viper or a rattlesnake, on the contrary, instantly produces intense pain, the bitten part quickly swells and becomes filled with bloody serum, and the whole limb is attacked by severe cramps. The patient suffers with burning thirst and dryness of the mouth, sometimes with hemorrhages of the eyes, stomach and bowels. The consequences vary with the circumstances of the bite. If the venom is introduced into a vein or a very vascular part, it almost always causes death by coagulation of the blood and embolism. If the bite is inflicted through the garments very little poison is absorbed, but even in this case the wound swells, sometimes enormously, and it may develop gangrene or phlegmons, the cure of which requires prolonged treatment. Convalescence is often very slow, the intellectual faculties may be impaired and, in children, an arrest of development has been observed. Temporary blindness has been noted in human beings, and it is frequently observed in



The fer-de-lance (Lachesis lanceolatus) of Martinique.



Imprints made on the skin by the bites of various serpents. At the left, non-venomous Colubridae; in the middle, venomous Colubridae; at the right,

domestic animals that have been bitten on the head. Bites on the head and neck are more dangerous than bites on the limbs, as fatal asphyxia may be produced mechanically by swelling of the throat.

The symptoms presented by the patient, therefore, show whether the serpent that has bitten him belongs to the viper or the cobra family. In some cases, an examination of the impression made on the flesh by the fangs and teeth will show whether the serpent was one or the other of these venomous reptiles, or a non-venomous member of the cobra family.

The gravity of the bite, of course, is proportional to the quantity of venom injected. When a serpent bites several persons in succession, it loses some of its venom with each bite, and the bites last inflicted are not very dangerous. A bite inflicted through leather or cloth leggings is less dangerous than a bite on the bare skin. The size of the victim should also be taken into consideration. The relative mortality is much higher in children than in adults.

Venomous serpents enjoy a considerable degree of immunity, especially against their own venom. Even non-venomous serpents show great resistance to serpent venom, and so do some mammals, including the hedge hog, the mongoose and the hog, all of which are great snake-hunters. The hedge hog, of course, is protected by its spines, and the domestic hog, which suffers little when bitten by serpents, is protected by its tough hide and its thick layer of fat.

More important than this natural immunity is acquired immunity. In every country infested with venomous serpents, there are persons who claim to be immune to the bites of serpents, either because they are insensible to the effect of the venom, or because they possess secret methods of treatment. Some East Indian snake charmers extract the fangs of the serpents which they exhibit, but there is no doubt that many perform with serpents that have not been thus treated, yet fatal accidents are rare among these people, who claim, perhaps with truth, to possess a secret process of immunization, which is handed down from father to son.

Fraser has proved that repeated ingestion, by the mouth, of small doses of venom gives white rats and young cats power to resist several times the normally fatal subcutaneous dose. Possibly the serpent charmers immunize their young sons by a similar method. It has been asserted that some serpent charmers cause themselves to be bitten occasionally by young cobras, and that others practise graduated inoculation. A similar method is employed by French viper hunters. Calmette knew one of them who took care to be bitten, at least once each year, by a young viper. If he neglected this precaution and then happened to be bitten, the effects of the bite were far more severe than usual.

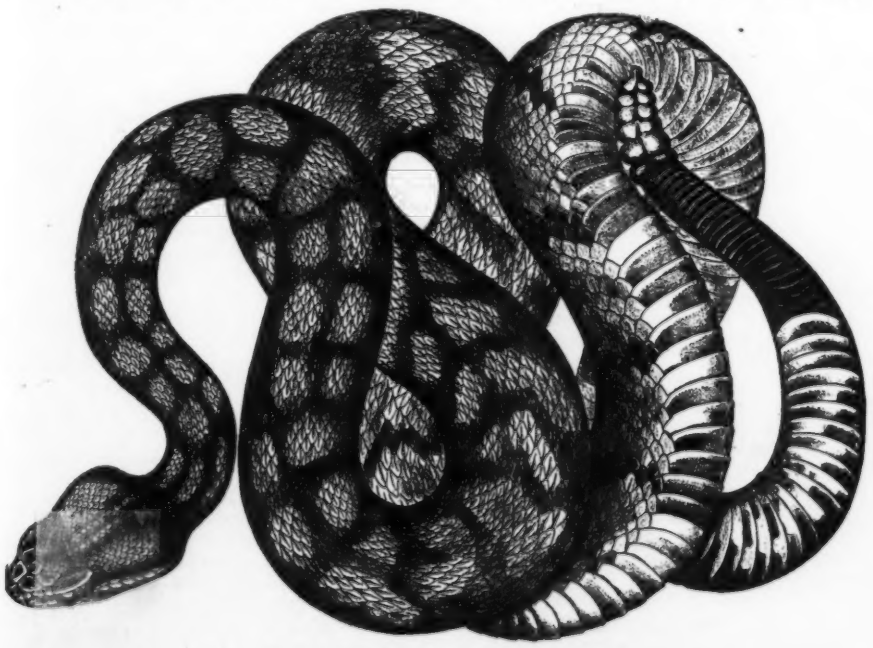
The researches of Calmette on cobra venom, and those of Phisalix and Bertrand on viper venom, proved that

Head of the red viper or asp (vipera asps).

animals can be made immune to several times the normally fatal dose of venom, by repeated hypodermic injections of very small doses, and that the blood serum of animals thus immunized possesses both immunizing and curative properties for that particular venom.

This is the principle of Calmette's serum treatment, which is now employed wherever venomous serpents constitute a public manace, and which has saved the lives of thousands of human beings and domestic animals. The serum possesses antitoxic, prophylactic and curative properties. That is to say, a mixture of venom and serum in proper proportions produces no effect when injected; an animal which has received a sufficient dose of serum is able to resist the action of normally mortal doses of venom, injected subsequently; and an animal which has received a normally mortal dose of venom can be saved by injecting serum without delay. The serum is most efficacious against venoms of the class from which it has been derived, but, in Calmette's opinion, the serum obtained from cobra venom is an effective antidote to the bites of certain *Viperidae*, including the vipers of France, the horned vipers of Africa, and the rattlesnake of America. This opinion is not shared by most authorities. According to Tidswell, Lamb, Martin and Vital Brazil, each serum is a specific antidote for the venom from which it is derived, so that the serum obtained from cobra venom confers immunity only against the bites of cobras and, theoretically, a special serum is required for each species of serpent. This difficulty is evaded, in practice, by using a polyvalent serum, obtained from animals inoculated with a mixture of venoms.

In most countries infested with venomous serpents, the teachings of Calmette are followed, and specific or polyvalent serums, adapted to local requirements, are prepared. In India, Semple obtains a serum from animals inoculated with the venoms of the two most common venomous serpents, the cobra and the daboia. In Brazil, Vital Brazil makes three serums—for the



The rattlesnake (Crotalus tinificus).

rattlesnake and two other species or classes. Rattlesnake serum is prepared in Philadelphia. At the Pasteur Institute of Lille, which supplies all the French colonies, Calmette produces a polyvalent serum from mixed venoms of *Colubridae* and *Viperidae*. The former are obtained in abundance from French Indo-China, but there is often a shortage in viper venom. Hence Calmette's serum is especially anti-neurotoxic, while its anti-hemorrhagic power varies greatly, according to the quantity of viper venom which the inoculated horses have received.

The serum is prepared by the following method: A horse is first injected with a mixture of venom and hypochlorite of lime. The injection is repeated every three or four days, the proportion of hypochlorite being gradually diminished to zero, and the operation being interrupted if the animal loses flesh. After this treatment has been continued about 16 months, the horse can withstand the hypodermic injection of 2 grammes (30 grains troy) of dry cobra venom, which is about 80 times the normally mortal dose, and is in condition to furnish an efficacious serum. The animal is then bled, 8 liters of blood being drawn 12 days after the last injection of venom, 6 liters after an interval of 5 days, and 6 liters after a second equal interval. These 20 liters of blood yield a little more than 10 liters of serum, which is decanted into bottles, which are sealed and sterilized. The serum retains its activity for several years, but more certain preservation for a much longer period can be assured by desiccating the serum and sealing it in glass capsules, each containing one gramme (15.4 grains troy) of the dried serum, which when required for use, is dissolved in 10 cubic centimeters (one third fluid ounce) of water that has been boiled and cooled.

If the patient is treated promptly, before toxic symptoms have appeared, a hypodermic injection of 10 to 20 cubic centimeters (one third to two thirds fluid ounce) of serum usually suffices to prevent poisoning in an adult. While awaiting the injection it is advantageous to ligature the limb, immediately above the bite, and to cauterize the wound with a red hot iron or a solution of potassium permanganate or hypochlorite of lime. If the bite has been inflicted by a large or very venomous serpent, 30 cubic centimeters (1 fluid ounce) of serum should be injected at once. The quantity of serum required varies directly with the time lost and the gravity of the symptoms, and inversely with the size of the patient. More is needed for a child than for an adult.

If the case is far advanced and the patient is in a critical state, there should be no hesitation about injecting 30 cubic centimeters into the veins, and repeating the dose if necessary. If the respiratory centers have already been affected, it is advisable to practise artificial respiration, in order to prolong the stage during which the organism can resist the venom until the serum can produce its effect. No matter how desperate the case may appear, there should never be any hesitancy about employing the serum, which has effected cures absolutely unhoped for.

Wherever the serum treatment is employed, the mortality among treated cases has become almost zero. In Sao Paulo, Brazil, of 275 cases treated with appropriate serums only one resulted fatally, and in this case the patient was at the point of death when the serum was applied. In India and some other countries, unfortunately, the natives rebel against the new treatment, and many deaths are still caused by venomous serpents. —Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from *La Nature*.

The Industrial Synthesis of Sodium Cyanide*

Probable That the Supply Will Exceed the Demand Through a New Development

By Charles Gravier

Of the three industrial forms of combined nitrogen—cyanides, ammonia and nitric acid—the cyanides occupy the lowest place in industrial statistics. While Chile annually produces 2,500,000 tons of sodium nitrate, and 1,000,000 tons of ammonium sulphate are furnished by gas works and coke ovens, the annual production of cyanides does not exceed 25,000 tons. The employment of cyanides has greatly increased since the introduction of the MacArthur and Forrest process in the metallurgy of gold, in 1888. Before that date, the annual production of potassium cyanide, the only cyanide then utilized, did not exceed 100 tons.

Four hundred and fifty tons were produced in 1888, 750 tons in 1890, 3,500 tons in 1895, and for several years there was a steady annual increment of about 1,000 tons, consisting partly of sodium cyanide, which had been introduced meanwhile. Almost the entire output of alkaline cyanides is used in the refining of gold, only a very small proportion being consumed in electroplating with gold and silver. But, though the cyanides occupy a comparatively small place in the great industry of nitrogen compounds, nitrogen in the form of cyanogen commands a higher market price than nitrogen in the form of ammonia or nitric acid, which are worth not more than 1.5 francs per kilogramme (13.2 cents per pound) of nitrogen, while the cyanides cost at least 6 francs per kilogramme (52.8 cents per pound) of nitrogen. In these conditions, it would be profitable to convert nitric acid or ammonia into cyanides. The transformation can be effected by various reactions, none of which has been utilized for converting sodium nitrate into sodium cyanide, though cyanides are actually made from ammonia. The inverse transformation is still easier to accomplish, as cyanides evolve ammonia when they are heated in a current of water vapor. Hydrogen cyanide, in presence of water, tends to decompose into ammonia and formic acid, while its salts, in similar conditions, yield ammonia and formates. At red heat, however, the formates split up into carbonates, carbon monoxide and hydrogen, so that the final result is given by the equation:

$$2NaCN+4H_2O=2NH_3+Na_2CO_3+CO+H_2$$

Many chemists are now endeavoring to effect the industrial systhesis of ammonia by way of the cyanides. To me this method appears illogical, because hydrocyanic acid, a compound formed from its elements by an endothermic reaction in which 30.5 calories of heat per gramme-molecule are absorbed, will always be more costly than ammonia, which is formed by an exothermic reaction, evolving 12 calories per gramme-molecule.

* Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from *Revue des Sciences*.

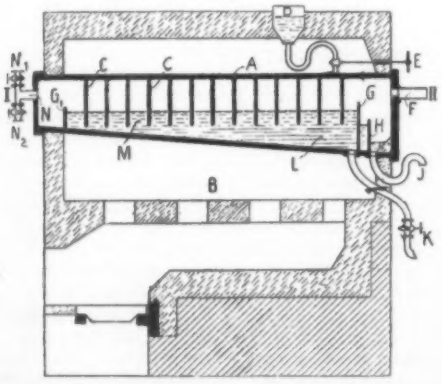


Fig. 1.—Castner apparatus for producing sodium amide.

A, horizontal retort; *B*, hearth; *C*, partitions; *M*, fused sodium; *D*, sodium inlet; *N*, ammonia inlet; *F*, hydrogen outlet; *J*, siphon; EKN_1N_2, cocks.

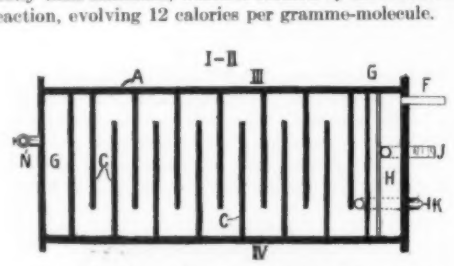


Fig. 2.—Horizontal section of retort for producing sodium amide.

The cheapness with which metallic sodium can be produced by electrolysis of fused soda, has made possible the development of a process by which a large part of the cyanide required by gold refiners is now produced from sodium, ammonia and carbon.

The English firm of Castner, whose name is intimately associated with the history of sodium, first devised these methods of obtaining the metal and its cyanide, but the industrial production of cyanide was made practicable by improvements introduced by the Deutsche Gold- und Silberscheide Anstalt, of Frankfort.

The chemical formula of sodium cyanide, NaCN, in which Na=23 and N=14, shows that nearly 2 kilogrammes of sodium are required in order to convert 1 kilogramme of nitrogen from the ammonia form to the cyanide form, and thus to raise its market value from 1.5 francs to 6 francs. The Castner electrolytic process, using a cheap source of electricity, furnishes the 2 kilogrammes of sodium for 2 francs, leaving a margin of 2.5 francs to cover other expenses and profits.

THE ORIGINAL CASTNER PROCESS FOR THE SYNTHESIS OF CYANIDES.

1. *Theory of the Process.*—It is well known that metallic sodium, at a temperature of about 400 deg. Cent. (752 deg. Fahr.) absorbs ammonia gas, forming an amide and liberating hydrogen.

$$NH_3+Na=NaNH_2+H$$

One molecule of this amide and one molecule of sodium cyanide, fused together, combine at 550 to 600 deg. Cent. (1,022 to 1,112 deg. Fahr.), yielding 1 molecule of sodium cyanide and free hydrogen.

$$NaNH_2+NaCN=Na_2CN_2+H_2$$

Finally, this molecule of cyanamide, mixed intimately with carbon, combines with it at 750 to 800 deg. Cent. (1,382 to 1,472 deg. Fahr.), forming 2 molecules of sodium cyanide.

$$Na_2CN_2+C=2NaCN$$

Thus the molecule of cyanide used in the process is recovered and a second molecule is gained.

By a modified process, in which the employment of cyanide as a reagent is avoided, the sodium amide is converted first into sodium cyanamide, and then, at 800 deg. Cent. (1,472 deg. Fahr.), into sodium cyanide, by direct combination with carbon.

$$2NaNH_2+C=Na_2CN_2+2H_2$$
$$Na_2CN_2+C=2NaCN$$

Castner's first idea was to produce sodium cyanide directly from its elements. As the combination is exothermic, evolving 50 calories per gramme-molecule, there can be no doubt of its possibility. I verified this theoretical deduction before I knew of Castner's researches. I obtained sodium cyanide by passing a current of pure nitrogen over a mixture of charcoal and sodium, but the yield of cyanide was small. Castner had previously, in 1894, made similar experiments. He poured fused sodium slowly on charcoal, heated in a vertical cylinder, to which a current of nitrogen was admitted by a lateral orifice. Sodium cyanide accumulated at the bottom of the cylinder. The quantity produced was greater than was obtained by passing nitrogen over a mixture of charcoal and sodium carbonate, but Castner soon recognized the advantage of substituting ammonia for nitrogen.

The original Castner process for the synthesis of sodium cyanide was conducted in two successive stages, sodium amide being produced in one apparatus at 300 to 400 deg. Cent. (572 to 752 deg. Fahr.) and converted into sodium cyanide in a second apparatus at 700 to 800 deg. Cent. (1,292 to 1,472 deg. Fahr.).

2. *Preparation of Sodium Amide.*—The reaction between ammonia and sodium takes place in a horizontal rectangular retort with a sloping bottom (*A*, Fig. 1). The upper part of the retort is divided into compartments by vertical partitions *C* which dip slightly into the liquid sodium *M*. These partitions, which do not extend entirely across the retort and are attached alternately to its two sides, compel the current of ammonia to pass

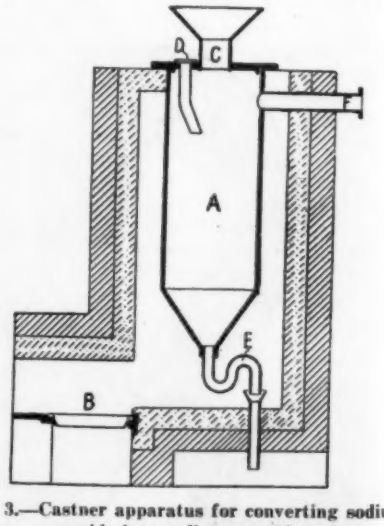


Fig. 3.—Castner apparatus for converting sodium amide into sodium cyanide.

A, retort; *B*, hearth; *C*, funnel for introduction of charcoal; *D*, inlet for fused sodium amide; *E*, siphon for drawing off sodium cyanide.

through the compartments successively and prolong its contact with the sodium.

The retort is heated to 300 to 400 deg. C. (572 to 752 deg. F.) and a little very dry ammonia is passed through it to expel the air. Fused sodium is then poured into the funnel *D* until it begins to overflow at *G* and escape through the siphon *J*. Ammonia, entering at *N*, is absorbed by the liquid sodium, the pure surface of which is continually renewed, as the sodium amide formed, also liquid, but heavier than the sodium, falls to the bottom of the retort, whence it flows, through a small orifice near the base of the wall *G*, into the chamber *H*, and escapes through the siphon *J*. The ammonia is entirely consumed; the hydrogen evolved escapes at *F*. Sodium has recently acquired considerable importance from its employment in the synthesis of indigo.

3. *Conversion of Sodium Amide into Sodium Cyanide.*—This transformation is accomplished in a cylindrical retort with a conical bottom (*A*, Fig. 3). The retort is filled with wood charcoal through the funnel *C*, and is heated to about 800 deg. C. (1,472 deg. F.). A stream of fused sodium is then admitted at *D*. The liberated hydrogen escapes at *F* and the liquid sodium cyanide flows through the siphon *E* into molds, in which it solidifies.

THE CASTNER-ROESSLER PROCESS.

Roessler, of the Deutsche Gold- und Silberscheide Anstalt of Frankfort, recognized the possibility of greatly increasing the efficiency of the second of the above-described operations, which comprises two successive reactions. At the temperature required for the formation of sodium cyanide, the sodium amide begins to decompose, disengaging nitrogen and proportionally diminishing the yield of cyanide. On the other hand, the sodium cyanide produced is accompanied by sodium cyanamide, the proportion of which increases the more the temperature is lowered. If the temperature is too high, therefore, a large part of the sodium amide is destroyed, while if it is too low, sodium cyanamide is produced instead of sodium cyanide.

After many researches Roessler succeeded in converting ammonia almost completely into cyanide by dividing the entire operation into three parts, producing successively sodium amide, sodium cyanamide and sodium cyanide. The first and second phases are conducted at a comparatively low temperature, 300 to 400 deg. C. (572 to 752 deg. F.), at which the amide is stable; the third at a high temperature, 800 deg. C. (1,472 deg. F.), which does not affect the cyanamide. As we have already seen, the amide can be converted into cyanamide either by fusing it with an equivalent quantity of cyanide or by heating it with charcoal to 350 to 400 deg. C. (662 to 752 deg. F.). In practice the fused amide is heated with finely-divided charcoal to 380 deg. C. (716 deg. F.). A violent evolution of hydrogen takes place and the mass gradually loses its fluidity, for the temperature of fusion of sodium cyanamide is 550 deg. C. (1,022 deg. F.). In order to complete the transformation, therefore, it is necessary to raise the temperature gradually to 550 to 600 deg. C. (1,022 to 1,112 deg. F.). In these conditions the theoretical yield of cyanamide is obtained.

The charcoal must be very finely divided in order to supply every molecule of amide with the carbon required for its transformation. It has been proposed to substitute liquid or gaseous hydrocarbons for charcoal. Acetylene is especially suitable for this purpose, but its employment would sensibly increase the cost of the product.

The Frankfort company and its licensees now conduct the three phases of cyanide synthesis successively in the same apparatus, consisting of a series of large iron crucibles. Each crucible is charged with 70 kilogrammes (144 pounds) of finely-divided wood charcoal and heated to 500 deg. C. (932 deg. F.). Dry ammonia gas is forced slowly through the apparatus to expel the air, then 100 kilogrammes (220 pounds) of sodium are added, the velocity of the ammonia current is increased and the temperature is gradually raised to 600 deg. C. (1,112 deg. F.), in order to complete the transformation of the amide into cyanamide. Finally, the temperature is raised to 800 deg. C. (1,472 deg. F.) to convert the cyanamide into cyanide, which is drawn off into molds and, after solidification, is ready for the market, without further treatment. The theoretical quantity of cyanide is produced, the loss being only that which is inherent to any industrial operation, but the temperature must be rigorously controlled. The product contains from 90 to 98 per cent of pure sodium cyanide, equivalent to 120 to 130 per cent of potassium cyanide, which is the standard adopted for estimating the value of cyanides.

This improved Castner process is employed in Germany by the Deutsche Gold- und Silberscheide Anstalt of Frankfort and the Elektrochemische Fabrik Natrium of Rheinfelden, in America by the Niagara Electrochemical Company, and in France by the Société d'Electrochimie.

Germany annually exports about 7,000 tons of cyanides and produces nearly one third of the 25,000 tons which the world annually consumes. England produces almost as much, and large quantities are made in France and the United States.

The Castner-Roessler process, although the newest, is by far the most important process of the cyanide industry, as its quantitative efficiency and the simplicity of its apparatus enable it to produce cyanide at a price that defies competition. The future of the process appears less certain, owing to the development of a new industry, which is obtaining from distillery and sugar refinery wastes a great variety of substances, including trimethylamine, which is subsequently converted into cyanide by heating it with metallic sodium.

$$N(CH_3)_3 + Na = NaCN + 2CH_4 + H$$

An experimental factory established at Nesles, France, already produces 2,000 tons, and is capable of producing 3,000 tons of cyanides annually. When this industry shall have been perfected and numerous factories established in distilling and sugar refining centers, it appears probable that the supply of cyanide will exceed the demand, and its price will be very low.

The Arms of the Venus of Milo

The End of a Mystery

In "Le Roman d'une statue," M. Jean Aicard, of the French Academy, has given a final and authoritative answer to the enigmas of that wonderful antique which the world at large, following the French spelling, knows as "the Venus of Milo." For now almost a century—92 years, to be exact—scholars and dilettanti have been forming theories as to the exact pose of the missing arms and hands. Some would have it that this particular Venus had carried a lance. One theory, very plausibly based upon certain lines in the "Hecuba" of Euripides, made the subject of this masterpiece not Venus, but Polynena, calmly advancing to the altar on which she is to be sacrificed, with: "Lay no hand upon me, for I am a daughter of kings." Henceforth there need be no more guessing as to those arms, what they meant, or what became of them. M. Aicard tells what they looked like before they were severed from the trunk, how they were severed, and even why the whole story has been left to obscurity and to guessing until now. And, as *Le Temps* remarks in giving its résumé of M. Aicard's monograph, when we know what this classic lady went through in 1820, the wonder is not that she lost her arms, but that she kept a head on her beautiful shoulders.

The trouble began when Iorgos Bottonis, in the early spring of 1820, undertook, with his son Antonios and a nephew, to clear a piece of ground on the Bottonis farm at Castro, in the island of Melos. While they were all three busy, the spade of one of them suddenly sank into a cavity beneath the surface. They at once investigated, and found a sort of vault. Breaking through the masonry of this vault, they found a statue of heroic size, representing a female, nude as to the upper half, but draped from the girdle to the feet, the drapery "held up below the hips by the right hand, while the left arm was raised, partly flexed, the hand holding a sphere not larger than an apple." To the right and left of the statue were two small figures, one the head of a woman, the other the head of an old man with a long beard.

Bottonis knew that every fragment of antique sculpture had a money value. He took measures to hide this precious find. It was the easier of transportation because it was not one block of marble, but three; one block for the upper part, another for the lower part, and a third for the right arm, which was attached to the shoulder by an iron peg. Still, the work was difficult to perform quietly, without letting the neighbors know. In the event, Bottonis, his son and his nephew succeeded in removing the upper half of the statue to their little hut, leaving the lower half, with its pedestal, in the vault.

It was only a few weeks later, on the 20th of April, that the good genius of the Louvre sent the French man-of-war "Chevrette" into the harbor of Castro, having first arranged that two of her officers, Lieutenant Matterer and Ensign Dumont d'Urville, should be inspired with archæological enthusiasm. These two officers were on the alert for antique finds, and, naturally, they got into communication with Bottonis, who showed them the lower portion of the statue where it still stood, in the vault, and then the upper portion in his hut. Next day the "Chevrette" sailed for Constantinople. This, we must remember, all happened before the Kingdom of Greece had come into existence, and when Melos was still Turkish territory. Arrived at Constantinople, they made haste to inform the French ambassador, the Marquis de Rivière, of their discovery. Bottonis had given them, it seems, an option on the statue, promising not to sell it without their consent, and this option was duly made over to their ambassador.

If these French suitors of the goddess had not relied so implicitly on Bottonis's promise to them, the "Venus of Milo" might have taken her place in the sight of men with her proper complement of arms and an unchipped shoulder. But M. de Marcellus, commissioned by the Marquis de Rivière to go and acquire the statue for his Government, was in no particular hurry. He did not reach Castro, on the schooner "Estafette," until the 23d of May—just in time to see a brig, flying the Ottoman flag, waiting in the roadstead, and a knot of Turkish sailors marching toward the strand. The Turkish sailors were carrying between them something white and heavy on a wooden litter; through a telescope, M. de Marcellus, on the deck of the "Estafette," got his first view of the Venus of Milo; and, for the moment, he feared it would be his last. But Commandant Robert, appraised of the state of affairs, acted promptly, and a cutter loaded with French blue-jackets was soon pulling for the shore. The sequel was a very lively scrimmage between French and Turkish sailors—not between the naval forces of France and the Ottoman Empire, or the incident would have been publicly acknowledged, and we should have known all its details long ago—only an unofficial scrimmage on the beach at Castro. The results of this unofficial action were: first, the Turks dropped Venus and made for their brig; secondly, the litter was smashed beyond any further use; thirdly, the French sailors, surmizing that the Turks would presently return with reinforcements, made all haste to haul the upper half of the statue (which was all that had been on the litter) with ropes over the rocks and loose stones down to where their cutter was beached. It turned out, on inquiry, that the pedestal and lower half had already been taken aboard the Turkish brig, but M. de Marcellus entered into negotiations, and the Turkish captain was induced to surrender his half of the prize. After all, why should a good Moslem fight, and perhaps forego substantial *bakshish*, for the sake of a fragmentary heathen abomination?

The French sailors were careful to pick up all the pieces that were knocked off in the course of their hauling or of the rough-and-tumble unofficial action which preceded it. That is, they picked up all they could find and brought them aboard the "Estafette" carefully wrapped up in canvas. These scattered members included the chip from the shoulder and much of the two arms; and so most of the Venus of Milo was conveyed to Paris via Marseilles. When this new wonder appeared in the antique gallery of the Louvre, people naturally asked questions about the missing arms and the great chip on her shoulder, perhaps the fractures showed fresh and white by contrast with the other creamy, time-stained surfaces; perhaps the authorities were canny enough to use a little wash of coffee. But at all costs the French Government had to discourage inquisitiveness in this direction; it would never have done—it would have raised a diplomatic scandal—to tell the international world about that unofficial scrimmage on the beach at Castro.

Now so far as this, M. Aicard has told us, though in a circumstantial and more logical way, little more than what many artists and archæologists have long vaguely understood, in spite of all theories to the contrary, that the two arms were broken in a fight when the French sailors were taking Venus away from her home of twenty centuries (the common story said that the fight was with the natives), and that one hand had held an apple. But the real importance of "Le Roman d'une statue" is in its authoritative character, derived, first from the hitherto unpublished memoranda of Lieutenant Matterer and Engisn Dumont d'Urville and, next, from the testimony of the late M. Jules Ferry. For reasons probably connected with the recent turn of affairs in the Balkan Peninsula, as well as with the lapse of time, M. Aicard believes that no harm can now come of laying the whole story before the world and depositing the manuscripts of Matterer and Dumont d'Urville in the archives of the Institute of France, for reference. As for the corroborative statement of Jules Ferry, it relates how, when he occupied the post of French ambassador at Athens, in 1872, he personally visited Castro and there found Antonios, the son, and the nephew of Iorgos Bottonis. These two remembered and were willing to substantiate the story of the discovery and the particulars about the appearance of the statue as it was when they found it. There can be no longer any doubt as to the original position of those much talked-of arms, or as to the much debated apple. The only subject now left open to conjecture is the fate of the two heads—the woman's and the bearded old man's.

A Remarkable Achievement in Slow Flying.—After the close of the Paris exposition the Paul Schmidt biplane was tested at Chartres before an Italian military commission. The minimum speed realized was actually 24½ miles an hour, and the ease of landing at that speed was remarkable. It was the world's record for slow flying.

Fig. 1.—A well preserved limestone block from an Egyptian tomb, 5,000 years old.

Deterioration and Preservation of Exhumed Antique Objects

The Remedy is Often Suggested by the Recognition of Its Cause

By Prof. F. Rathgen

Fig. 2.—A block from the lower part of the same tomb, corroded by salt water.

Most antique objects of art have been found buried in the soil, where they have lain, more or less excluded from the air, for hundreds or thousands of years. Some retain their original appearance, while others show various changes, and many which appeared unaltered when exhumed have since exhibited symptoms of decay. In inorganic material, the change after exhumation is almost always due to the presence of sodium chloride, sodium sulphate or soluble salts of magnesia, which have permeated the objects during their subterranean sojourn.

The ever-varying humidity of our climate causes alternate solution and crystallization of these salts, which mechanically affect the pores and crevices, and lead, in stone and similar material, to the formation of large cracks, and the removal of the surface in the form of scale, sand and dust. Fig. 1 shows a limestone block, taken from an Egyptian tomb 5,000 years old, and now in the Berlin Museum. Its surface is almost uninjured. Fig. 2 shows a block from the lower part of the same tomb, which must have been saturated with a saline solution, for it has scaled badly since it has been in the museum. Similar changes occur in objects of burnt clay. Egyptian objects are especially liable to decay, which is not surprising, as the soil of Egypt was formerly submerged and subsequently retained the salts of the sea. Many Egyptian objects have been found incrusted with salt, and one clay vessel was found broken by the force of crystallization.

Elsewhere, especially in Asia Minor, buried objects have been infiltrated with gypsum (calcium sulphate). The cuneiform inscriptions of many Babylonian clay tablets are covered and made illegible by gypsum crystals, which in many cases also have produced cracks and splinters. Fig. 3 shows a clay tablet with a large crack which was probably developed by the crystallization of gypsum in a fine crevice.

An example of the crumbling produced in sandstone by saline ingredients is furnished by a sandstone grating in the church at Emden, which was flooded by a tidal wave in 1825. The intermittent action of the sun's rays has caused repeated crystallization and solution of the salt, which has also affected the binding material of the stone, allowing the grains of sand to fall asunder.

The remedy for this disintegration is suggested by the recognition of its cause. It was formerly believed that objects of stone and clay could be preserved by impregnating them with resin, glue or water glass, but as a rule this treatment only retards decay. In current practice, the destructive salts are leached out, using distilled water for small and valuable objects, and pure river, spring or rain water for large objects, and especially for limestone blocks. First, however, it is necessary to ascertain that the object will endure immersion in water, which is not always the case. The water is changed frequently in the beginning, weekly at the end of the treatment, and its gradually diminishing salt content is estimated by a simple chemical method.

The leaching of the 125 limestone blocks of the Egyptian tomb mentioned above required the employment of

Fig. 3.—Clay tablet, cracked by crystallization of gypsum.

30 tanks for two or three years. Meanwhile it became necessary to install 200 additional tanks, in a specially constructed pavilion, for the treatment of 400 boxes of glazed tiles, which came from the Processional Street of Nebuchadnezzar's palace in Babylon, the leaching of which occupied 18 months.

Fig. 4.—A badly cracked Egyptian statuette.

In many cases, additional treatment is required, after leaching. The surface of limestone is hardened with "Fluat," and the glazed side of the Babylonian tiles was saturated with paraffin, the excess of which was removed by rotary brushes. In this way, the small cracks, which had been produced by long burial and which made the glaze opaque, were filled with paraffin, so that the colors of the inner layer again came to light.

Sometimes special precautions are required in leaching. A badly cracked limestone statuette (Fig. 4) was first bandaged (Fig. 5). After leaching and drying, it was saturated with melted paraffin and the bandage was not removed until it had cooled.

Incrustations of calcium carbonate must be removed by mechanical means from limestone, but they can be removed with very dilute hydrochloric acid from material which is not affected by acids. Of course, it must be ascertained that the object is actually acid-proof, and the acid must be completely removed by washing.

The incrustations which are found on clay tablets, and which usually consist of mixed gypsum, lime and clay, are removed by heating in a muffle oven to about 600 deg. Cent. (1,112 deg. Fahr.) after a prolonged sojourn in a drying oven at 120 deg. Cent. (248 deg. Fahr.). Very gradual heating and cooling are necessary to eliminate danger of cracking the tablets. After cooling, the incrustation can be blown off or removed with a soft brush, in many cases. In other cases the crusts are washed off in the prolonged soaking in water which is required for the removal of salts. The successful application of this process is illustrated in Fig. 6, but the material is not always as good as this. Many clay tablets consist of numerous fragments which, after treatment, must be put together as well as possible.

In contrast to stone and clay objects, the deterioration of which is due chiefly to physical causes, metal objects undergo chemical changes while they lie buried in the earth. The rusting of iron is a well-known fact, but it is not so generally known that large quantities of sand, clay and pebbles sometimes become firmly united with the iron in the process. Iron objects thus contaminated were formerly cleaned mechanically and then immersed for a long time in hot petroleum varnish or turpentine varnish. It was believed that the objects were permanently protected from further oxidation by the air-excluding coating formed by combination of the varnish with the rust already present. After a longer or shorter period many objects so treated exhibited symptoms of increased oxidation and were again soaked in varnish, but ultimately fell completely into decay. The cause of this decay was subsequently found in the presence of iron chlorides formed by the action of salt water on the interred iron objects, many of which are deformed by large hard blisters, filled with oxides and chlorides of iron.

If the object is so badly rusted that its form would be seriously affected by removing the rust, the only thing to do is to preserve it in its rusted condition. All soluble chlorides are leached out, and the object is dried perfectly and immersed for several hours in a mixture of linseed oil varnish and turpentine at 100 deg. Cent. (212 deg. Fahr.). It is better, however, to plunge the object, while still wet, into melted paraffin at 120 deg. Cent. (248 deg. Fahr.). Thereby the water is completely vaporized and the paraffin enters and fills every void. When the bath has cooled to 80 deg. Cent. (176 deg. Fahr.), the object is taken out and wrapped loosely in a cloth, in which it is allowed to cool. Accumulations of paraffin in surface depressions are removed mechanically, the last traces being spread by applying a small flame.

If the layer of rust is comparatively thin it may be completely removed. This was formerly accomplished by Blell's process of immersion in dilute sulphuric acid, in which the rust was lifted by hydrogen, evolved by the action of the acid on the metallic iron. An electrolytic process, in which no good metallic iron is destroyed, is now used. In Finkener's process, the iron object is wound with platinum wire connected with the zinc pole of a galvanic battery, and is immersed in an electrolyte, opposite a piece of platinum foil connected with the copper pole. In Krefting's process, the iron object is made a part of a galvanic cell by wrapping it with strips of zinc and immersing it in weak soda lye. In both processes, water is decomposed and hydrogen is evolved at the surface of the object, but the iron is not attacked. The hydrogen detaches the rust mechanically and also exerts a reducing action, especially on the iron chlorides. The hydrochloric acid thus produced is leached out, and the object is then treated with varnish or paraffin in the manner already described.

Fig. 5.—The statuette of Fig. 4, bandaged by leaching.

Fig. 6.—Incrusted clay tablet, before and after cleaning.

Fig. 7.—An Egyptian bronze thickly covered with patina.

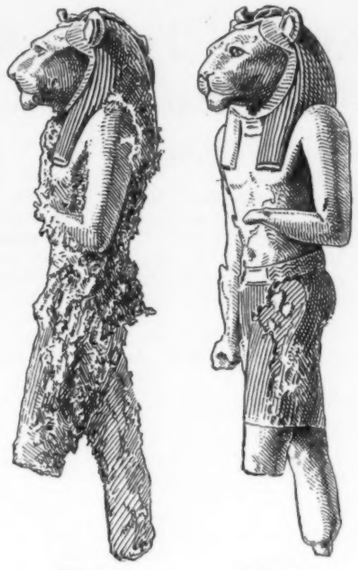


Fig. 8. Fig. 9.

Fig. 8.—An Egyptian bronze covered with wild patina. Fig. 9.—The same bronze after removal of the patina.

Fig. 11.—A "diseased" tin medal.

Fig. 10.—The same bronze after electrolytic treatment.

The appearance of exhumed objects of bronze and copper is exceedingly varied. In addition to the highly prized blue-green "noble" patina, composed of carbonates, oxides and hydrates of the metal, and forming a thin coating that reveals the finest detail, there are other patinas which disfigure the object directly, and also by cementing it to sand, clay and stones. A variety called wild patina, which often does not appear until long after exhumation, is due to the formation of chlorine compounds of copper by the action of salt water in the soil. In moist air these compounds may continue to react on the metal until the value of the bronze is destroyed. Wild patina occurs usually in the form of pale green spots, which increase and multiply until they cover the entire surface, which crumbles and falls off as a green powder. When the patina is removed, the metal is found to be eaten away in spots to a depth one sixteenth inch or more (Figs. 8 and 9).

If the freshly exhumed bronze is so greatly corroded that little metal remains intact, it can be protected from further deterioration by a coat of paraffin. Leaching in water is generally useless because the chlorides are of the basic class and are insoluble. If the wild patina forms a thin layer, or deeper corrosion is found only in spots, it is advisable to apply Finkener's or Krefting's electrolytic process, which, as in the case of iron objects, reduces the chlorides and oxides to the metallic state.

These processes are recommended also for bronzes having a good patina which deforms the object by its excessive thickness, or the inclusion of earthy matter, which is detached by the reduction of the cementing chlorides and oxides. Bronzes that have been subjected to a reducing process require leaching, and this is a difficult operation, especially with some Egyptian castings, which inclose partially sintered cores, composed of sand and salty calcareous clay. It is preferable, therefore, to complete the leaching in the electrolytic bath, which in this case consists of water, to which a trace of ammonia is added to confer electrical conductivity. Reduced bronzes need no paraffin, but a coat of zapon is desirable, especially for Egyptian bronzes containing much lead, which, on drying, become covered with an ugly gray film. This film is brushed off, as well as possible, and a more metallic appearance is produced by applying zapon. It would be easy to produce an artificial patina, but this is not done, as a matter of principle. Figs. 7 and 10 show an Egyptian bronze before and after cleaning.

Objects of gold undergo no change, and require only washing with soda and water.

Silver objects are often found covered with a thick layer of silver chloride, produced by the action of salt water. Such objects are treated by the electrolytic process. Many leaden objects show a coating of white lead, which is caused by handling. The sweat acids attack the lead, forming salts which react with atmospheric carbon dioxide and moisture, producing white lead and releasing the acids, which attack fresh portions of metal. Leaden objects are best treated electrolytically and, after drying, coated very thinly with wax.

Objects of tin are sometimes affected by the "tin disease," which is simply a transformation from the metallic to the non-metallic state. The change is caused by exposure to cold and never occurs unless the temperature falls below 18 deg. Cent. (64.4 deg. Fahr.). The reverse change to the metallic form can be effected by heating to the melting point, but this is obviously impracticable in the case of valuable objects. The best that can be done is to prevent the attack or the spread of the disease by keeping tin objects in rooms that are never cooler than 18 deg. Cent. (64.4 deg. Fahr.).

The cabinets of all well-conducted museums are nearly dust-proof. If they are also air-tight, and contain sticks of caustic soda, which absorbs both moisture and carbon dioxide, their iron and bronze contents, even if already affected and not specially treated, will be permanently protected from deterioration. Some authorities recommend cases filled with nitrogen.

The causes and symptoms of decay in organic materials are too well known to require description. In museums, the moths that destroy textiles and the worms that infest wood are killed by fumigation, usually with carbon disulphide, in closed cases, preferably exhausted of air. Poisons are seldom employed. The arsenites are the best; corrosive sublimate, formerly much used, may be reduced to calomel and thus made ineffective by the organic matter. The unreliability of naphthalin as a moth preventive and its inferiority to camphor are recognized by nearly all curators. Badly worm-eaten wood is filled with paraffine or resin in order to give it strength, and the worms are killed in the process. Petroleum is seldom used to destroy worms in museums, because of its inflammability.

In most museums, freshly exhumed wooden objects, which are often very soft and require careful protection against drying during transport, are subjected to a special filling process. Basket work, cordage, bones, horns, etc., are also filled, usually with paraffin, which may be regarded as the most reliable and indispensable preservative for museum objects in general.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from *Umschau*.

Life at Low Temperatures

COLD, no matter how intense, does not destroy all life. This is the startling and significant statement made by Nordmann in an article in the *Revue des deux Mondes*.

However, this expert on the subject of cold modifies his statement by reminding us that man and the other "so-called superior" animals must not be taken as the criterion of *life*, since they are but complex structures built up of simpler elements existing in harmonious union.

"The fundamental substratum of the phenomenon 'life'," he continues, "is the cell, the primordial atom of all living beings.

"But the very lowest temperatures which have been realized during the last few years leave intact a great number of cells, spores and bacteria. Recent researches, of which the first were made at the Royal Institution of London have established this incontestably. Prof. Macfayden proved, in a series of beautiful experiments extending over some years, that the germinative power of grains was not attacked at the temperature of liquid air (—190 deg. Cent.), and of liquid hydrogen (—252 deg. Cent.), no matter how long the exposure lasted. The action of liquid air on bacteria was perfectly harmless. After months of immersion in liquid air in a sealed tube no weakening of their power of growth and their functional activities was observable when they were again brought to the ordinary temperature."

He next cites phosphorescent organisms as offering a brilliant example of this suspension and resumption of vital activities. "Frozen in liquid air they no longer emit light; but the intercellular oxidation which produces the oxidation recommences vigorously as soon as the temperature is raised. Again, the pyorganic bacillus of charrin, after weeks of immersion in liquid air, begins at once to secrete the blue matter which gives it its name."

Even more surprising is it to learn that certain microbes have been frozen and heated alternately a number of times without injury, plunging them first into liquid air and then without transition stages into water at +50 deg. Cent.

"All these experiments on spores, grains, bacteria, repeated more recently with liquid hydrogen and then with liquid helium have given the same results, though helium approaches absolute zero. . . . The experiment of Paul and Ball is especially striking. They employed vegetable forms in the dry state (not spores) of staphylococci, which are bacteria. But though these creatures ordinarily live but three days at the usual temperature, their vitality was not sensibly diminished after months spent at the temperature of liquid air."

Pictet claims to have obtained similar results recently with higher animals, such as fishes and frogs, but without pausing to consider the dreams of human life prolonged which this suggests, we pass to certain important problems on which this subject touches. "To begin with, the cold of siderial spaces no longer opposes an argument, as was long supposed, to the theory of the transmission of vital germs from star to star."

Nordmann next speaks of the preservation and transportation of food and of medical "cultures." It has been hitherto forbidden to doctors to make use of vaccines more than 40 days old, since they have lost their virtue in that time. "But many experimenters, notably Carnus, have proved the virulence of vaccines persists indefinitely when they are kept in cold storage." This obviously permits the keeping of large reserves of vaccine on hand, and of shipping to remote points.

Finally Nordmann discusses the value of refrigeration in the practice of transplanting living tissues, as in the experiments of Dr. Carrel and others. Megitst even succeeded recently in preserving for many days the delicate and putrescible human cornea, successfully transplanting it in place of one injured by burning.

SEVENTY per cent of the world's cork is produced in Spain and Portugal. According to the *Journal* of the Royal Society of Arts, there were produced in Spain during 1912, approximately, 78,000 tons of cork, of which 54,780 tons came from the Seville district, 12,650 tons from Cataluna and Castellon, 7,100 tons from Galicia, and 3,460 tons from the two Castille provinces. The finest cork is grown in various parts of the provinces of Seville, Badajoz, Caceres, Cadiz, Huelva, Cordoba, Gerona, Barcelona, Castellon, Ciudad Real, Toledo, Malaga and Salamanca. The greater part of the finest cork, however, grows in the neighborhood of Barcelona, and most of the low-grade cork is produced in Seville. The total number of cork factories in Spain is 892, distributed over 107 towns. These factories produce for export 8,964 tons of cork, 746 tons of small squares, 583 tons of other manufactured cork, and 50,198 tons of cork wood and cork waste. About 5,500 tons of cork sawdust are used in Spain annually in packing fruit for shipment. Some 40,000 persons are employed in some manner in the cork industry in Spain, with an average wage of about 2s. 9d. per day.—*The Engineer*.

The Industrial Need of Technically Trained Men

Engineering as a Life Work—Electrical Engineering

By W. H. Abbott

For a young man who is about to choose a profession, it is often a most preplexing question what that profession should be. Happy is he who has a most decided predilection which is actually based on the peculiar bent of his mind. The inherited callings, for instance, being a doctor because one's father is a doctor, is a most dangerous thing, since it so frequently happens that the candidate has never had a chance to even consider anything else.

Every mind seems to have additional powers in certain directions. Under a competitive system of existence, it is more than wise to follow this line of least resistance, no matter how desirable it may be to cultivate the qualities which we lack in order to make full rounded men. I would suggest that the qualities lacking be selected as hobbies and cultivated during one's leisure time.

Another point on which the young man is very likely to go wrong is that he thinks that he should not take a college course, but should begin at the bottom and work up on the practical side, since the practical side is so highly prized in the business world. This seems logical and is if he will remember that he must learn everything covered in the college course, even though he does begin in the shop. Practice is a wonderful thing as an aid to theory, and if one starts early enough it does not matter very much which comes first, but both must be had. The college course, in connection with the college laboratory, is probably the easiest solution of a most difficult problem.

Further than this, even in electrical engineering, there are positions to which an engineer may aspire which do not require an engineering training, yet an engineer may fill them to advantage as compared with a man with a business training only. Such positions always carry with them salaries and a consideration superior to that of engineering alone, and are obtained not by engineering ability but by those other qualities which distinguish men, and which qualities are greatly enhanced by a college training. The qualities themselves are, however, probably inborn and cannot be originated by any form of training.

The first question that the candidate must decide is, has he the quality of mind which would justify him in choosing some form of engineering? The quality of mind which probably embraces all forms of engineering is that of an infinite curiosity directed more particularly to happenings in the world we call matter. For instance, an infinite curiosity pertaining only to men should make a sociologist, to mind alone a psychologist, to all things equally a philosopher. To curiosity as to matter, must also be united the desire to be a builder or operator; this last being the distinction between the quality of mind of the scientist and the engineer.

Given the curiosity and the actual desire for manipulation, one can safely conclude that he is fitted for some form of engineering. The matter of choice then becomes paramount. Again it reduces itself to a question of quality of mind. The various branches of engineering differ almost entirely in the size of particles of matter dealt with and the kind of motion to which they are subjected. For instance, in bridge and structural work, the masses are usually large and the condition of lack of motion is the cardinal principle; in hydraulics, the masses of water are frequently acres in extent and the motion usually slow. The same applies to mining. In railroad work, the masses are smaller and the motion faster. In mechanical work, the elements are usually small and the motion fast. In metallurgical work, the particles in action are very small and the motion becomes that of the molecules of the matter. In pure electrical work, the masses are the smallest and the motion exceedingly fast, being that of the smallest divisions of matter. In other words, we progress from matter at rest to matter in its highest stage of motion. The choice should therefore depend on which of these divisions of size and motion most interests us. Which we can most readily visualize and think about without undue strain. At the very bottom, they are probably all equally difficult, but not for all minds.

No doubt the psychologists will soon have some tests worked up that will enable us to distinguish much more clearly as to what are our mental qualifications. Many mistakes would be avoided if some decisive tests could be applied.

At this point, however, it is important to point out that since the divisions between the branches are graduations of mass or motion or both, they necessarily overlap. This is particularly true of electrical and mechanical engineering. All truly electrical phenomena show themselves or are produced by mechanical means, and usually through more or less complicated mechanical tools. Hence these two divisions go so closely together that many college faculties for a long time refused to separate them. Even though the separation has now been made, it seems that the practice of many students in combining the two courses is advisable even if it takes somewhat longer.

The similarity of mechanical and electrical engineering is strikingly shown by the main subdivisions of each.

Electrical Engineering	Light.
	Power.
	Transportation.
	Transmission.
Mechanical Engineering	Power.
	Transportation.
	Transmission.
	Manufacturing.

Both are doing practically the same work, but are doing it in a different way. The electrical method in nearly every case is to substitute for a series of mechanical forms some simple electrical form usually operated at a higher velocity. This substitution of electrical details for mechanical details is proceeding very rapidly in all manufacturing industries. To make such substitution requires, however, as wide a mechanical knowledge as an electrical. It will not be at all surprising to find a strong subdivision springing up in the future, the specialists in which will call themselves electro-mechanical engineers, in the same way that we already have electro-metallurgists. The quality of mind for each of the above leans strongly to the electrical. This is seen very clearly among skilled workmen in construction operations. The best mechanical helpers are uncertain of themselves as soon as some piece of electrical apparatus is injected into a machine. Many of them seemingly cannot think along the combined lines and are willing to give up on little difficulties on which they would have spent hours striving for a solution if along mechanical lines alone.

The very latest developments indicate that the close connection between electrical and mechanical engineering is rapidly extending to all branches of engineering. In other words, that we are to have electro-metallurgists, hydro-electric engineers, electro-mining engineers and electric railway engineers. All of them must get their initial training along electrical lines and then specialize among the subdivisions; the subdivision thereafter becoming their principal subject. In other words, the province of electricity in these subdivisions seems to be either in the elimination of mechanical parts or in an increase in the output. Hence the engineer must be most thoroughly acquainted with the fundamental possibilities of electricity.

If then a young man is attracted by electric phenomena, that is, can readily visualize the unseen, and in addition is strongly attracted by some other department of engineering, he can readily combine the two and find a field sufficiently wide for all his ambitions.

All actual practice of engineering divides itself into *operation* and *design*.

Operation includes all erection work and must be the field of the majority of engineers. In electrical work, due to the large factories establishing student courses, this fact has been somewhat overlooked. The factory for the manufacture of electrical apparatus is the home of the designing engineer. Hence, if from the financial standpoint it is necessary for a young engineer to advance rapidly and he is not a born designer, he had better not spend too many years in the factory.

The operating engineer should be active physically and have a more general education than the designing engineer. He will come in contact with the public at every turn, and the public will not appreciate his detailed knowledge of electricity or mechanics. A man who knows things in general will appeal to it as an able man—and success in many places is determined by what the public thinks.

The operating engineer must also have a knowledge of business or merchandising. All successful operation is measured by the two sides of a ledger account. An operating engineer must face that ledger and know something of how the accountant manipulates it. Reputations are made and marred behind the bookkeeper's desk as well as around the work benches. An operating man who can check accounts or make up his own statement of what it is costing him can weather more storms than one who is in the hands of his "friends."

In many departments of operation, the social side of the manager counts for much. In electric light operation it frequently makes the difference between a successful and an unsuccessful man. The ability to dance well will make stronger friends and more of them than artistic draftsmanship, although that is desirable. In other words, the full rounded man is the one looked for as manager of all public service corporations, and the number of these is legion.

The designing engineer must be a specialist. He is the student of the engineering fraternity. His theoretical training should be most thorough. He must have that rare combination, the mathematical mind combined with originating genius. Most of all, he must realize the importance of details, and the detailed history of his profession.

The number of positions open for designing engineers is small. The road to design is up through the drafting room and out through the complaint department. All present day practice is toward standardization, which much reduces the field of the designer, and that not infrequently to the damage of the apparatus turned out. Standardization has been carried to its greatest extreme in this country. The largest field still open is in the design of systems or combinations of units, as in laying out power houses, transmission lines, or factories. This, however, more frequently falls to the operating engineer than it really should, due to the operating man being in closer contact with the owners or financiers of such enterprises.

Rare Gases

THERMAL springs all give off rare gases. It is a well-established fact that neon, argon, krypton, xenon and helium are all found in the mixture of gases emitted from such sources, as also that if the first four are present in the same proportion as in air, the fifth, helium, is always found in larger proportion, sometimes much larger. Thus, at Maizieres the crude gas contains nearly 6 per cent of helium.

Mouren and Lepape, who have made extensive studies in this line, have found still larger percentages of helium elsewhere. At Santenay, three springs gave off a gas in which the amount of helium varied from 8.4 to 10.6 per cent.

These figures suggest that there are actual deposits of helium in the neighborhood of springs which emit gases.

Localities.	Percentage of Helium in Crude Gas	Debits.	
		Liters per Annum of Spontaneous Gas	Liters per Annum of Helium
Santenay (Cote d'Or):			
Lithium Spring	10.16	51,000	5,182
Carnot Spring	9.97	179,000	17,845
Fontaine Salée Spring	8.40	.....	.....
Maizieres (Cote d'Or):			
Roman Spring	5.92	18,250	1,080
Gresy (Saone-et-Loire):			
Source d'Ys	2.18	.....	.....
Bourbon-Lancy (Saone-et-Loire):			
Lymbe Spring	1.84	547,500	10,074
Néris (Allier):			
César Spring	0.97	3,504,000	33,990
La Bourboule (Puy-de-Dome):			
Chossy Spring	0.01	30,484,800	3,048

Helium being one of the products of the disintegration of radio-active substances, it is believed that this helium of thermal springs is either very young, disengaged as produced, or else entirely fossil, i. e., liberated a very long time subsequent to its accumulation in the minerals. But the question is, which?

The Carnot spring yields 17,845 liters per annum, but it would require 91 tons of radium, or 500,000,000 tons of pitchblend or thorianite to produce this volume, if we accept the first hypothesis. For the second, the annual disaggregation of 2 tons of thorianite, or 167 tons of pitchblend, or 300,000 tons of granite would suffice. Hence the second hypothesis appears more reasonable.

It will be noted that the first five places in the table lie in a strip of territory oriented southwest to northeast. Obviously considerable deposits of helium must be located within this strip.—*Bibliotheque Univers.*

Map of the World to a Scale of One Millionth

M. CHARLES LALLEMAND, Director of the Service and Organization of the General Leveling of France, has given some information concerning the last conference of the international map of a millionth scale. At the first conference, which was held at London in 1909, only seventeen countries were represented. At the present time thirty-one states have joined the convention. M. Lallemand also announced that the Prince of Monaco was taking upon himself the expense of several oceanic pages.—*Chemical News.*

Chemical Fire Extinguishers*

Apparatus May Throw Water Mixed With Ingredients to Quench Even Large Conflagrations

GENERAL interest in methods of fighting fire has been renewed by three recent catastrophes: the destruction of the largest Zeppelin airship, the explosion in the Cardiff coal mine, and the burning of the steamship "Volturno."

Water, the substance most extensively employed for extinguishing fire, exerts a purely physical action by cooling the burning material below its ignition temperature. The abundance and wide distribution of water and its high specific heat and latent heat of vaporization make it pre-eminently suitable for this use, but the catastrophes mentioned above prove that it is not a universally effective antidote for fire. There are many cases in which water is not available, and others in which the peculiar character of the fire makes it useless. To this latter class belong fires in inflammable liquids which, being lighter than water, float on its surface and thus extend the area of the conflagration. In such cases, and in others where water fails or cannot be had, chemical extinguishers afford an effective means of fighting fire.

The development of the chemical fire extinguisher has been a long and laborious process, and it is not yet complete. The earliest apparatus of this sort was invented by Greyl, of Augsburg, in 1715. It consisted of a cask filled with water, immersed in which was a sheet metal box, containing about two pounds of gunpowder, connected with a fuse that passed through the top of the cask. When the cask was thrown into a burning building the gunpowder, ignited by the fuse, exploded, shattering the cask and scattering the water in all directions. The extinguishing effect was due partly to the violent impact of the water and partly to the gases evolved by the combustion of the gunpowder.

The fire extinguishing cartridge, invented by Kuehn in 1846, is a capsule filled with sulphur and saltpeter which is ignited by a fuse and thrown into the burning house or room. The result is a copious evolution of sulphur dioxide, 2 per cent of which in the atmosphere makes combustion impossible. The filling of the cartridge is composed of 66 parts saltpeter, 30 parts sulphur, and 4 parts charcoal. A cartridge of a different make contains 59 parts saltpeter, 36 parts sulphur, 3 parts charcoal, 1 part sand and 2 parts iron oxide.

We now come to a group of fire extinguishers which are designed to exclude air from the burning objects by covering them with an incombustible powder, the evolution of incombustible gases being incidental and of secondary importance.

These dry extinguishers, which are sold under various names, are conical vessels of sheet metal, filled with a fine yellowish powder, which chemical analysis proves to consist chiefly of sodium bicarbonate. The extinguisher is usually hung on the wall and the lid opens automatically when it is taken down. Some interesting experiments were made by the exploiters of one of these extinguishers. A cask two thirds filled with tar, covered with petroleum and benzine, was set on fire. When the flames had attained a height of 4 or 5 feet, a handful of the extinguisher powder was thrown into the cask. The fire was extinguished instantly. In another experiment, a trench 5 feet long and 1 foot wide was filled with benzine, which was ignited, and was quickly extinguished by throwing upon it the contents of an extinguisher. In a third experiment, a shed 8 feet wide and high and 30 inches deep, formed of three board walls and a roof, coated with tar and sprinkled with benzine and petroleum, was set on fire and extinguished by the contents of one extinguisher.

A special merit of these dry extinguishers is the entire harmlessness of their contents. The superiority of the powders to water for quenching the flames of petroleum, benzine and the like makes them especially suitable for use in varnish factories, garages, aeroplanes and airships.

As considerable skill and strength are required in order to throw the powder upon the burning objects with sufficient force, one inventor has devised an apparatus which accomplishes this result by the pressure of carbon dioxide. A small steel cylinder of compressed carbon dioxide is attached to a larger cylinder containing the sodium bicarbonate mixture. The two cylinders are connected by a tube, provided with a valve, the opening of which causes the powder to be blown violently from the larger cylinder.

We come now to a class of extinguishers which employ water in addition to chemical agents. The simplest and oldest type is the American hand grenade, a globular flask of thin glass containing a solution of barium chloride, sodium chloride, calcium chloride, ammonium chloride, ammonium sulphate and other salts, which vary in different makes. When the grenade is thrown upon the burning objects and shattered, nitrogenous gases are evolved which add their extinguishing effect to that of the water. Another predecessor of the modern extinguisher is an English apparatus, consisting of a strong-walled bottle filled with sodium bicarbonate solution and containing a glass tube filled with tartaric acid. When the tube is opened the contents of the bottle are ejected in a fine stream by the pressure of the carbon dioxide produced by the action of the tartaric acid upon the sodium bicarbonate.

The automatic chemical fire extinguishers that are now so extensively employed possess the merit of generating the pressure required to eject the stream of water, so that the work of pumping is eliminated. As a rule, however, the pressure diminishes steadily until the apparatus is emptied, and so much time is occupied in recharging that it is usually preferable to bring a second extinguisher into action, if possible, when a single charge does not suffice.

The capacity of an extinguisher of any practical utility should be at least 10 liters (2½ gallons), but it cannot exceed 30 liters (8 gallons) without making the apparatus unwieldy. Extinguishers of this general type are made and sold under a great variety of names in Germany, Austria-Hungary, Russia, France, Spain, Great Britain and America.

These extinguishers may be divided into two groups, distinguished by the method of pressure production. In the smaller and less extensively used group, compressed air or carbon dioxide is employed, and the operation of the extinguisher can be interrupted and resumed at will. One apparatus is provided with a steel cylinder of compressed air and is charged with 9 liters (2.4 gallons) of a solution of "antigrit," a compound which is said to prevent the freezing of water at —20 deg. Cent. (—4 deg. Fahr.) to evolve nitrogen and to cover the burning objects with a saline incrustation. Another apparatus, made in capacities of 8.5 and 13 liters (2.2 and 3.4 gallons), employs compressed carbon dioxide. A third device which has also a carbon dioxide cylinder provided with a safety valve, employs a hose to direct the stream of water.

The numerous extinguishers of the second group, which are more commonly used, are operated by carbon dioxide produced by chemical action between sodium bicarbonate and an acid. In some forms of apparatus, the acid is contained in an uncovered vessel and is mixed with the soda solution by tipping the extinguisher. In other forms, the acid is in a sealed glass tube or in a closed vessel with a leaden bottom, which must be torn open by a mechanical device. The uncovered acid container has the demerit of allowing acid to escape gradually in the form of vapor and combine with the soda solution, while the sealed glass tube presents the disadvantage of producing splinters which may clog the outlet.

The duration and rate of flux, and the distance to which the stream is thrown, are important points to consider in selecting an extinguisher. One Austrian apparatus ejects from 2 to 3 kilogrammes (4.4 to 6.6 pounds) of fluid per minute for 3 to 4½ minutes. A very extensively used German extinguisher throws 4½ to 5 kilogrammes (10 to 11 pounds) per minute for 1 to 1½ minutes. The range of this apparatus is from 8½ to 10 meters (28 to 33 feet). It is doubtful if the range of any extinguisher exceeds 10 meters, though a range of 15 meters is sometimes claimed. The range usually falls off rapidly toward the end of the flow, so that a continual approach toward the fire is required.

The extinguishing agent used in a Russian apparatus is foam, produced by dissolving licorice in the water. Ammonium acetate or ammonium chloride is also added, to prevent freezing, and the acid solution contains alum, which increases the extinguishing effect. One form of this apparatus, devised for extinguishing fires in benzine and other inflammable liquids, which are only spread by a stream of water or even by a forcible stream of foam, is constructed to pour the foam gently upon the burning liquid, and thus to form an air-excluding blanket. That this effect is actually produced has been proved by many tests, in one of which a blazing surface of tar, more than 100 square feet in extent, was extinguished by hand extinguishers of this type. For use in more extensive fires of this character the apparatus is constructed in two larger models. One of these models is operated by a force pump, contains 50 liters (13 gallons) of fluid, producing 260 liters (69 gallons) of foam, and is provided with about 12 feet of hose and a flat shovel-shaped nozzle. The other model dispenses with the pump, operates automatically when tipped, is mounted on wheels and contains 150 liters (40 gallons) of fluid, which yield 900 liters (238 gallons) of foam. In a test made by the Hanover Fire Department, a wooden hut, measuring 10 by 16 feet, filled with hay, straw and kindling wood, and saturated with oil and benzine, was set on fire in a strong wind, and extinguished by means of two of these large extinguishers.

The success obtained with this apparatus suggested the employment of a similar method for extinguishing fires in large oil tanks and storehouses for inflammable liquids. For this purpose, a stationary apparatus is used. The two liquids, acid and alkaline, are stored in containers of capacities proportioned to the size of the establishment. From these containers the liquids flow through pipes which join in a single system of pipes, in which the foam is produced by chemical action between the two liquids, and by which the foam is distributed throughout the establishment.

The method was tested by the Hamburg Fire Department at the Wilhelmsburg oil works. The two liquids were forced by steam pumps from large iron underground tanks into mixing chambers in the vicinity of dangerous points. The tough viscous foam generated in these chambers was forced under pressure into a net work of pipes, from which it could be either sprayed through hose or allowed to flow directly into the blazing oil tanks. In the official test an iron tank filled with inflammable liquid and surrounded by a fire wall was ignited by an explosion that blew off the cover and cracked the side of the tank, so that some of the burning liquid escaped into the space between the tank and the fire wall. The conflagration was extinguished in 2½ minutes by spraying the foam through two lines of hose.

In experiments made subsequently in Rotterdam by a Berlin firm, 30,000 liters (7,900 gallons) of benzine were fired and the following points, the especial subjects of investigation, were satisfactorily established: The foam can be conveyed to a great distance through pipes, and even through hose. It can be forced to any desired height in stand pipes. It is not destroyed by passing through red hot pipes. It may, like water, act by the impact of its fall, but so high a fall is required that only its lateral application need be considered in practice. The cast iron pipes successfully withstood the intense heat to which they were exposed.

The Fire Prevention Committee of London has also indorsed this system, which is being installed in several large oil works.

We see, therefore, that chemical methods may be useful even in large fires, when the necessary apparatus has already been installed, and it is not impossible that the effect of the water thrown on other conflagrations by our fire-engines may some day be increased by the admixture of chemical ingredients.

*From an address by Councillor Wendt, published in *Zeitschift fuer angewandte Chemie.*

Agricultural Motors in the West Indies

AGRICULTURAL motors are being introduced with some measure of success into various of the islands of the West Indies. According to the *Ironmonger*, in St. Kitts, St. Lucia, Montserrat and Antigua the soil is deep and in some parts heavy, and motor engines can be profitably employed in those islands. In Barbados the soil is not deep, and coral rock occurs in so many places that motor ploughing may be found inpracticable, except on certain estates lying in the valleys. So far estate owners have little knowledge of improved methods of ploughing, and any company that would demonstrate the working of this machinery in the islands should have little difficulty in securing the support of the Imperial Department of Agriculture and of the local agricultural societies.—*The Engineer.*

Relations of Muscular Exercise to Altitude

AN interesting communication has been presented to the Académie des Sciences by M. Vallot and M. Bayeux concerning the relations of muscular exercise to altitude, says the Paris correspondent of the *Lancet*. They made use of a squirrel confined in a rotary cage, and were able to determine that the animal at the sea level made 6,700 turns of the wheel a day. After this fact had been established by repeated observations, the animal was taken in his cage to the summit of Mont Blanc, at which altitude it made only 900 turns a day. When brought down to the plain it made 5,000. This experiment clearly shows that the fatigue felt on muscular work by Alpinists is not solely due to the exertions of climbing, even though they take a considerable part in it. As a matter of fact, the person or animal transported without fatigue to the summit finds himself in a medium in which the rarefaction of the atmospheric pressure and the diminution of oxygen are sufficient to diminish muscular energy. Similar observations have been made on the men, horses and mules which work in the cordilleras of the Andes.—*The Engineer.*

Stereoscopic Pictures of the Moon*

Obtaining a Mate for One Good Lunar Photograph Requires Long Waiting and Precise Exposures

If a spherical body, like the moon, s to appear spherical, and not plane, it must be seen simultaneously by two eyes separated by a distance which is not too small a fraction of their distance from the sphere. That is to say, if the eyes are represented by *A* and *B* (Fig. 1) and

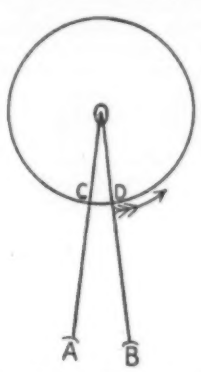


Fig. 1.—Illustration of stereoscopic vision.

the spherical object by the circle whose center is *O*, the ratio $\frac{AB}{AO}$, or the angle *AOB*, must equal or exceed a certain minimum value. If the eyes are too close together or too far from the sphere, that body will present the appearance of a flat disk.

The distance between the human eyes, about two and one half inches, is sufficient to produce the effect of roundness, or stereoscopic relief, in near objects, but it is quite inadequate in the case of the moon, which is nearly 240,000 miles away. Now, we can neither bring the moon nearer, nor increase the distance between our eyes, but we can photograph the moon simultaneously from two widely separated places on the earth's surface, and combine the two photographs by means of the stereoscope, which exhibits one photograph to the right eye and the other to the left eye. In order to obtain a fairly good stereoscopic effect, the two plans must be at least 4,000 miles apart—approximately the distance between Paris and Chicago. In this case, taking *A* and *B* (Fig. 1) to represent the two cities, the angle *AOB* would be about 57 minutes.

Still better stereoscopic pictures of the moon can be obtained by taking the two photographs from the same place at different times. The selection of suitable times of exposure is not a simple matter. The change in the relative positions of the moon and earth which is caused by the difference between their orbital velocities is compensated, in general, by the fact that the moon rotates on its axis in the same time which it occupies in performing a revolution about the earth, so that it always turns nearly the same face toward the earth. The far more rapid rotation of the earth would enable a lunar astronomer to produce excellent stereograms of the earth by making two exposures at an interval of four minutes, in which time the earth would have turned through an angle of one degree, which we have seen to be sufficient. But a Chicago astronomer, seeking to utilize the earth's rotation for obtaining stereograms of the moon, would be compelled to defer his second exposure until the earth's rotation had carried him to the point occupied by Paris at the time of the first exposure, and during this interval of several hours the moon would have altered so greatly in phase that the two photographs would be unfit for combination in the stereoscope.

In short, it would be impossible to make a satisfactory pair of stereograms at one observatory if the moon's relative orbit were a true circle lying exactly in the ecliptic, i. e., the plane of the earth's orbit. Fortunately, however, the relative orbit of the moon is an ellipse, having the earth in one of its foci. Unlike the majority of astronomical orbits, that of the moon, if drawn to scale on paper, could be distinguished from a circle by the naked eye, but it is less oval, or eccentric, than it is represented, for the sake of clearness, in the diagram (Fig. 2). Its real eccentricity, expressed by the ratio which the distance between the focus and the center bears to half the length of the major axis (the ratio $\frac{OM}{AM}$ in Fig. 2) is about one eighteenth.

In consequence of the elliptic form of its orbit, the moon's orbital velocity is variable. According to Kepler's second law, the radius vector, i. e., the line which joins a planet to the attracting body about which it revolves, sweeps over equal areas in equal times. It follows that the linear velocity increases as the radius vector diminishes, and conversely. That is to say, the moon's orbital velocity is greatest when the moon is nearest to the earth, and least when the moon is most remote from the earth. In Fig. 2 the earth is represented by the small circle *O*, and various positions of the moon are indicated by *A*, *B*, *C*, etc. *A*, the point of the moon's nearest approach to the earth and greatest velocity, is called the perigee; *G*, where the moon is most distant and its velocity is least, is called the apogee. The moon, starting from its perigee, *A*, traverses in one fourth of its time of revolution something more than a quarter of its orbit, and reaches a point *E* such that the area bounded by *OA*, *OE* and the curve is equal to one fourth of the area of the ellipse. In the diagram, *E* is placed at the extremity of the ordinate drawn through the point *P*, which is the second focus of the ellipse, situated as far to the left of the center *M* as *O* is to the right. As *DE* is approximately equal to *MP*, and consequently to *MO*, the triangles *EQD* and *MQO* are nearly equal. *AOE*, the area described by the radius vector, can be derived from the quadrant *AMD* by adding the triangle *EQD* and subtracting the triangle *MQO*. Hence the area *AOE*, described by the radius vector, is approximately equal to one fourth of the area of the ellipse, and, by Kepler's law, the time occupied in going from *A* to *E* is approximately one fourth of the periodic time of revolution.

In this interval, the radius vector, or the line connecting the earth and the moon, has turned through the angle *AOE*, which is greater than a right angle, but, as the rotation of the moon on its axis is perfectly uniform, the moon itself has turned (very approximately) through a right angle, so that the lunar hemisphere, which faced

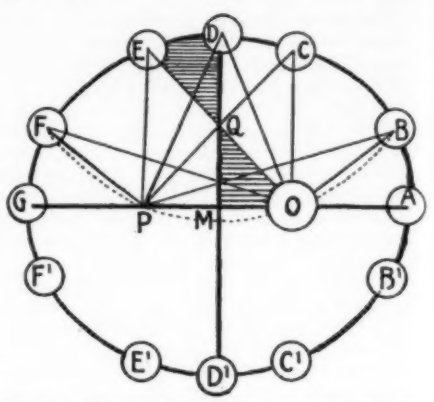


Fig. 2.—Diagram of the moon's orbit and motion.

the earth at the perigee *A*, now faces the other focus *P* and the earthly observer, looking along the line *OE*, sees a slightly different hemisphere. In general, the moon, throughout its revolution, turns the same face toward *P*, and not toward *O*. By this simple rule it is easy to determine the amount by which the visible face of the moon, at any point of its orbit, is displaced from its position at perigee. This displacement, which is called libration, increases from zero at *A* to a maximum at *D*, diminishes to zero at *G*, increases again, but in the opposite direction, to a maximum at *D'*, and finally diminishes to zero at *A*.

In the passage from perigee to apogee, the libration is called westerly, because any point of the moon's disk, a lunar mountain, for example, appears displaced to the west of its normal position; in going from apogee to perigee, the libration is easterly.

The libration changes most rapidly when the moon is near perigee or apogee, and attains half its maximum value at the points *B* and *F*, where the ellipse is intersected by a circle described from *D* as a center, with a radius *DO=DP*, for the angle *PDO* is measured by the arc *PO*, while *PFO=PBO* is measured by half that arc.

The maximum angle of libration *PDO* (grossly exaggerated in the diagram) is nearly 8 degrees, which is amply sufficient for stereoscopic effect, and more than eight times the relative displacement of two lunar photographs made simultaneously at Paris and Chicago. This difference can be obtained by photographing the moon at various pairs of points, such as *A* and *D*, *D* and *G*, *G* and *D'*, *D'* and *A*, *B'* and *B*, or *F* and *F'*. Even a smaller difference will suffice.

But, in addition to the libration in longitude, there is a libration in latitude, due to the fact that the plane of the moon's orbit is inclined more than 5 degrees to the ecliptic, so that at one time the moon is north of the ecliptic and we see more of its south polar region, and at another time it is south of the ecliptic and we see more of its north polar region. The libration in latitude must be reckoned with and eliminated, as its effect is injurious. There are other librations, but they are so small that they need not be considered.

The two exposures, of course, must be made in the same phase of the moon. We cannot, for example, combine photographs of the moon at *A* and *D in the same revolution*, because, if the first photograph shows a full moon, the second, taken a week later, will show a half moon. A single hour's difference in phase is clearly perceptible in good lunar photographs. In the fine photograph shown in Fig. 3, the optical or apparent center of the lunar disk, as seen from Paris at the instant of exposure, is indicated by a small white circle, and the true center, a fixed point on the moon's surface, is marked by a small white cross. The librations in longitude and latitude are measured by the horizontal and vertical distances between the cross and circle. The mountain Pico, whose peak shines like a star from the dark half of the disk, near the bottom of the photograph, was entirely invisible an hour earlier, but visible to its foot an hour later.

In stereoscopic photographs, a difference of a few hours is admissible, because a moderate deficiency in illumination in one photograph is compensated by the other. Within these limits the phases must agree, or to speak more accurately, they must differ by an amount equal to the difference in longitudinal libration, so that the terminator, or boundary between light and shade, crosses the same mountains and craters. The librations in lati-

Fig. 3.—The moon in its first quarter. From a photograph by Loewy and Puisseux, Paris.

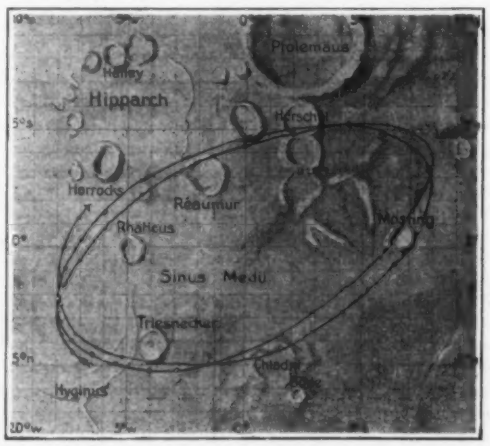


Fig. 4.—Path described by the apparent center of the Lunar Disk.

* Adapted from an article by P. Langbein in *Kosmos*.

tude therefore, must be as nearly equal as possible.

It would be convenient for our purpose if the optical center simply oscillated to and fro along the lunar equator, but the combination of the ever varying librations in longitude and latitude causes it to move round the true center in a series of oval curves. The path followed by the optical center in November and December, 1911, is indicated on the chart (Fig. 4) on which the great craters Ptolemy, Hipparchus, etc., have been sketched for convenience of comparison with the photograph (Fig. 3). At this period, the monthly curve was increasing in width. Six months previously it was a very narrow oval, almost touching the true center on each side and extending from northwest to southeast, and six months later it was a similar narrow oval, extending from northeast to southwest. Although each monthly curve differs appreciably from its predecessor, all of the curves are included in, and tangent to, a rectangle formed by the lunar meridians of longitude 7 degrees 53 minutes 51 seconds east and west, and the lunar parallels of latitude 5 degrees 8 minutes 48 seconds north and south. This remarkable endless curve has another significance. It represents the apparent course of the earth, as seen from the moon. To a lunar observer, therefore, the earth does not appear absolutely stationary, as is stated in many astronomical text-books, nor does it seem to move in a simple ellipse, as others assert, although its movements are confined to a small region of the sky and its apparent course during a single month is nearly elliptical. The explanation and calculation of its complicated path would be a fascinating problem for a lunar astronomer.

The most methodical procedure, for the obtaining of stereoscopic lunar photographs, would involve tracing the curve for several years in advance, and drawing across it a line parallel to the lunar equator. The numerous intersections of the curve with this line represent epochs of equal libration in latitude, while two intersections on opposite sides of the zero meridian differ considerably in libration in longitude. The next step is to select two such intersections (on any one parallel of latitude near the equator) which agree in phase. The construction and examination of so complex a drawing would be a formidable task.

Before describing a simpler method, it should be observed that the sharp shadows of lunar mountains in the vicinity of the terminator give considerable plastic effect to a single good photograph of the moon, or to the appearance which the moon presents to a single eye, looking through a small telescope. The perspective foreshortening, by which the apparent ellipticity of the craters is gradually increased from the center to the edge of the disk, adds to the impression of roundness. The mountainous south polar region looks like an earthly landscape viewed in the usual manner at a very small angle. The effect of stereoscopic pictures of the moon is heightened by the same causes.

Now let us suppose that we have made one good lunar photograph and wish to obtain a stereoscopic mate for it. In the first place, we must await a month in which the libration in longitude, at the same phase, is conspicuously different. As the libration depends on the position of the perigee, which moves entirely around the orbit in 3,232½ days, an appreciable difference will appear in a few months, but the condition that the libration in latitude must be the same at both epochs may delay the second exposure several years. A pair of stereoscopic lunar photographs, reproduced in *Kosmos* in 1911, were made in the months of April, 1896, and February, 1900.

In the second place, we must wait, on the night thus selected for the second exposure, until the terminator falls exactly on the meridian which marks its position in the first photograph, so that, for example, the same mountain peak is just emerging from the shadow in both views. In other words, the two exposures should be made, not when the moon is precisely in the same phase, but when the shadow falls on the same points of the lunar landscape.

The Shaw Electric Measuring Machine

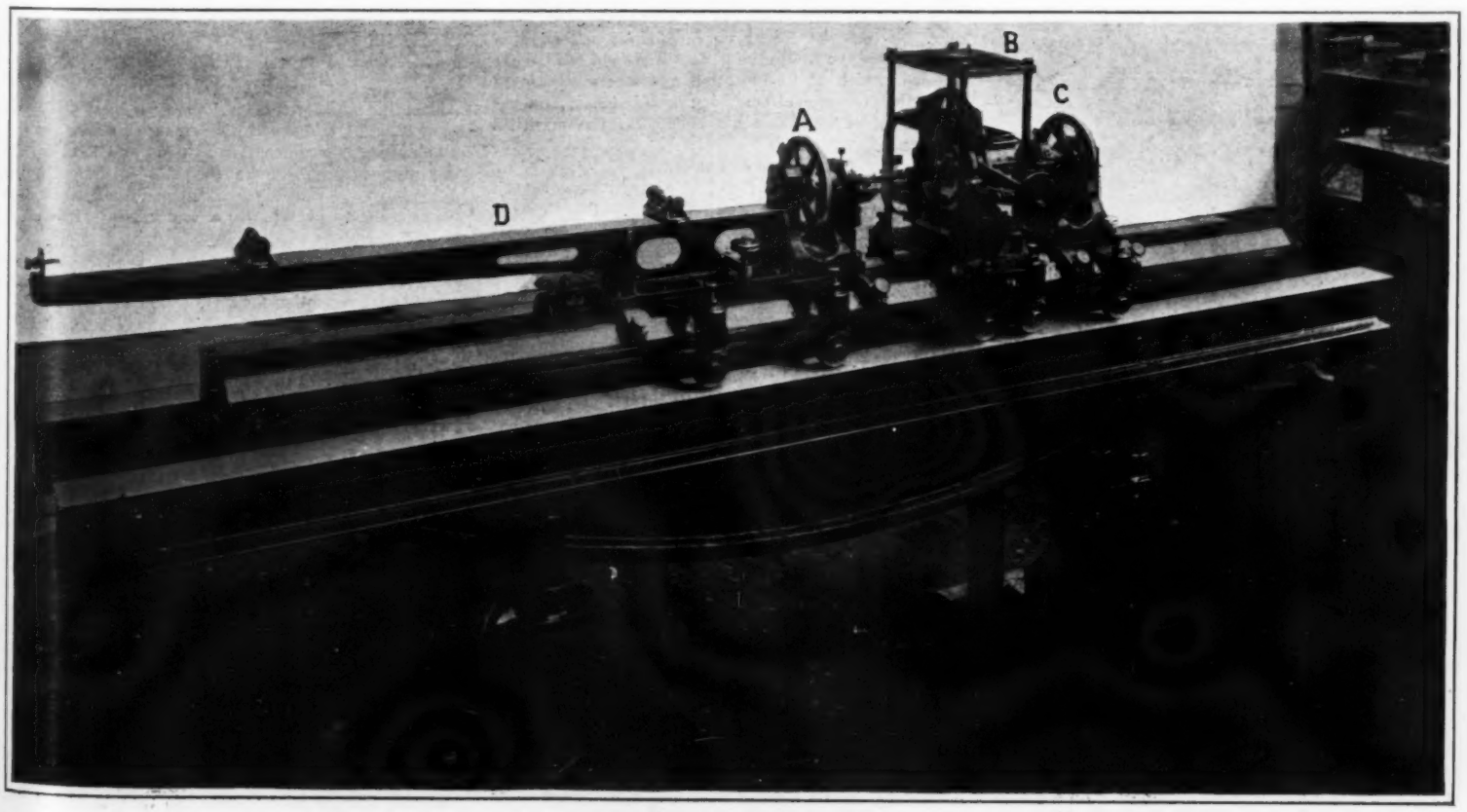
The Promise of the Increasing Accuracy Required for Modern Engineering Work

By the English Correspondent of the Scientific American Supplement

THE new electrical measuring machine which is the invention of Dr. P. E. Shaw, a prominent English engineer, is intended to follow the demand for ever-increasing accuracy such as is now required for modern work. What is generally adopted as a standard for measurements of length in many classes of engineering work is a length-gage such as a rod, block or plate having the ends very accurately faced off and calibrated to a standard marked length. Common lengths of such gages are from one foot down to one inch, or fractions of an inch down to thin plates of 0.1 inch. Very accurate gages of this kind are now supplied by constructors, but as a large number of commercial measurements are made by this means in carrying out different classes of work, and these depend upon the supposed accuracy of the metal rod or block gages, some good testing method must be provided for checking up their accuracy. Such operations belong properly to the well-equipped standardizing or metrological laboratories, and at the present time these laboratories make use of measuring machines of a more or less complicated nature and based on mechanical principles. An advance in this class of machine is now made by Dr. Shaw, and it is claimed that it will allow of making measurements down to a closer limit and at the same time it avoids quite a number of the drawbacks which are seen in the present class of machine.

What led principally to the design of a new and more accurate apparatus, such as the electric method alone could give, was the need of making critical examination of the best modern gages, notably those made by Johansson in Sweden. These latter have now attained a unique position on account of their accuracy and adaptability, and consist of steel blocks or slabs with very true end surfaces of about 35 by 10 millimeters, and of different lengths all on this same cross section. The true faces have repeatedly been proved, both by optical and mechanical tests, to be plane and parallel to a degree of accuracy which is hitherto unattained in metal pieces. One peculiarity of this gage system is that the unit blocks can be placed together end to end and used in combination, so that given a variety of small gages, longer ones can be made by simple addition, such as 1.000 inch + 0.750 inch + 0.500 inch = 2.250 inches. What is remarkable is that the end faces of the block are so true that by pressing them together, the blocks adhere to each other simply by atmospheric pressure, and thus make up a solid piece for use as a gage. It is especially for testing this and other very accurate modern block or rod gages that Dr. Shaw's electrical apparatus is designed.

The machine consists of a base formed of two long pieces of I-beam which serve to carry most of the weight of three carriages which move along upon sets of rollers. As the object is to make each of the carriages *A*, *B* and *C* move forward and back in an exactly straight line, there is provided a sliding way in the shape of a casting mounted between the long girders, and this piece carries two faced-off surfaces running along the whole length. The front slide surface is beveled on front and back as in the usual triangular scale, while the rear slide has a flat surface. The carriage in each case carries feet provided with screws which bear upon the faces of the two slides in such way that the carriages travel upon the rounded ends of the screws and thus have an easy and accurate sliding movement. The rollers are in the shape



The Shaw electric measuring machine.

of spring-socket casters with ball bearings, and as most of the weight comes upon them, the weight borne by the sliding part is but small.

The aim of the machine is to hold one or a pair of rod or block gages such as are seen in the middle carriage *B*, which is termed the gage holder, this carriage being then clamped in fixed position upon the slide. The left hand carriage or headstock *A* is provided with a micrometer whose scale lies around the rim of the large wheel, and by turning this wheel the pointed micrometer end is advanced until it comes in contact with the end of the gage. In the same way the right hand headstock *C* carries an identical micrometer for working with the other end of the gage. On the gage holder carriage is fitted a very complete device for clamping the gage in place, and then for giving it all the needed movements such as are used to bring various points on the flat end of the gage block opposite to the pointed measuring end, so as to allow the end to explore the surface of the block. The wheel seen at the front serves to work a screw so as to procure the sidewise movement of the gage, while a similar screw at the top produces a vertical motion, then by means of the circular parts which have the shape of a gimbal mounting, the gage can be tilted at any angle by screws, so that the present carriage allows of giving all possible adjustments to the gage piece within the needed limits.

Supposing the gage to be firmly fixed in place and the carriage clamped down, should we turn the micrometer on one of the headstocks, this advances the measuring-end or point until it comes in contact with the gage surface, but in the present electric method this mechanical contact is not what is used. In fact, the measuring end has a spring mounting so that it can be farther pushed in as we continue to advance the screw, and a farther movement causes an interior electric contact between two metal pieces. This completes an electric circuit consisting of a high resistance of about 5,000 ohms, a cell, switches and telephone. As soon as the telephone sounds, the observer reads the divided wheel of the micrometer screw by means of the microscope (not shown) which lies before it. On reversing the micrometer screw, the contact is broken and the telephone again sounds. Naturally the micrometer is properly calibrated so as to take account of electric contact with the gage.

The first measurements relate to exploring the left hand face of the gage in order to see whether it is true, and to take the errors upon the various parts. First the gage is shifted so as to bring the near side of the gage face opposite the end, and the reading is then made with the micrometer. Shifting the gage forward so as to bring the contact on to the far side, we take a second reading, and as this generally differs from the first we adjust the gage by the screws so as to make both readings identical. Carrying out the same operations for top and bottom, we now have the gage as nearly straight as possible. Then by taking about eleven points all over the face and exploring each point by the measuring end, tables of figures are obtained which show very exactly the state of the surface and whether it is true or not. The instrument measures to within 0.1 micron or 1/10,000 millimeter. Having tested the front face of the gage block or bar, we now proceed with the rear face, and by exploring the surface we obtain a second set of figures. In like manner it is possible to find whether the two faces are perfectly parallel or whether they are wedge-shaped by a very small angle. The Johansson gages are so accurate that even the presence of small particles of dust between the built-up blocks will cause an appreciable error, and this is either shown as wedge shape, that is, the ends not being in true parallel, or as an all-over increase in the length.

In order to make absolute measurements of length of gages, the left hand carriage has fitted to it a standard metal measuring bar of say 3 foot length, it being clamped along the cast iron support projecting to the left. This bar has engraved measuring lines across its top face, and by shifting the carriage a certain line is set under the cross-hairs of a microscope (not seen). The standard bar has however no actual end contact with the measuring micrometer, but is of course in a fixed position with it on the same carriage. Supposing the bar to be set with a certain engraved line under the cross-hairs, then the two measuring ends to be screwed out till they touch (the middle carriage being suppressed), certain figures are had which serve as a base. Then shifting back the left carriage to bring a second line under the cross-hairs, we note exactly the amount of such shift, and as any further movements of the micrometer are also noted, calculation gives us the exact length of a gage which may now be in place. However, as it it practically impossible to be sure of the meeting of the two measuring ends in the first place, the actual method used is somewhat different from the above and involves comparing a standard block gage with the one to be measured. As this operation cannot be briefly described, we will limit ourselves to the present account of the Shaw electrical apparatus, and it will be seen that it is one which promises to be most useful in this class of work.

Deepening the Suez Canal

A Record of Progress

WHEN the Suez Canal was originally made, for a great part of its 100 weary miles nothing but a mere furrow cut through sandy desert, it had a depth of 8 meters, or 26 English feet. At various periods it has been deepened until it reached its present depth of 39 feet. Operations are now in progress with a view to making it uniformly 39 feet deep, a process which, with other great works of improvement also going on, will involve a very large expenditure. In one respect the Suez Canal has a fortuitous advantage over other great artificial waterways, such as, for instance, the Panama Canal and the Manchester Ship Canal—it is not affected by tides to an appreciable degree, and has therefore no need of locks. There is not a single lock between the almost tideless Mediterranean and the Red Sea, and the waterway remains constantly at an almost uniform depth. The 39 feet will represent the minimum depth at low tide at Suez.

QUESTION OF DRAUGHT.

The principal reason given for this new departure is the obvious one—the necessity of providing for the transit of larger vessels. The first vessel to pass through from sea to sea after the opening of the flood gates in 1865 was an 80-tonner. The largest vessel that has been through in its period of latest development is the Hamburg-Amerika liner "Cleveland," measuring 588 feet long and 65 feet broad, with a molded depth of 46 feet, and of 17,340 registered tonnage. The "molded" depth of a vessel is not, of course, its draught depth, but something very much greater. No vessel is at this moment permitted to pass through the canal which draws more than 29 feet of water—a measurement which allows a clear margin of 3 feet between the keel and the bed of the waterway. With an added 7 feet the range of traffic will be very considerably expanded, though the canal company are by no means persuaded that the needs of the not very distant future will be met even by this improvement. A vessel measuring 46 feet wide may safely pass another of the same dimensions even in the narrowest part of the canal (146 feet), provided the strict rule is conformed with, that no vessel shall pass another while both are under headway. In the early days vessels could pass only at a few cross places, or *gares*, with a collective length of less than a mile, but passing is now possible anywhere, under the conditions mentioned, owing to the widening improvements that have been made from time to time. Partly owing to this cause, but also in large measure owing to the use of searchlights, which render transit, except in the case of sailing craft, possible by night as well as by day, the passage of the canal from end to end has been reduced from an average of 36 hours to half that time within the last 25 years. The maximum speed permitted to vessels of any type is 5.1/3 nautical miles per hour.

SAND STORMS.

While the sand storms to which the Suez Canal is exposed are among the causes which make constant dredging necessary, they are not a factor of much weight in promoting the new deepening project. As a matter of fact, the deposit lodged in the most exposed parts of the waterway by these eruptions is infinitesimal. The greatest mischief is done at Port Said, in the early months of the year, when cross-currents drive before them great billows of sand, and a part of the extensive improvements now in hand is the extending of the breakwater at the port by some 2,700 yards, at a cost of about $3,000,000, to counteract this evil.

The mention of some of the extreme precautions required under the rules of navigation of the canal in order to insure safety, tempts allusion to others as not remote from the subject of deepening and widening. Before any vessel is allowed to enter the canal the captain must see to it that the yards are braced forward, the ladders and jib-booms run in, and the boats swung in. The tie-up hawsers must be ready for rapid handling; the bow anchor must be ready to let go; the searchlights must be in good working order. When the journey has commenced there must be a watch both by day and night; there must be no overtaking of one ship by another; no vessel must anchor in the canal except in case of absolute necessity; no ashes, cinders or articles of any kind must be thrown overboard; if any article falls overboard the vessel must not stop to pick it up, but report the matter to the company's officials at the nearest station; and when a collision appears probable there must be no hesitation in running aground if necessary. So the list might be indefinitely extended of rules enforced to secure the perfect transit of the famous channel, which at its inception and afterward caused so much international confusion and jealousy, and has since been of immeasurable benefit to the maritime interests of every land.

NO PREFERENCE.

Since, under the wise foresight of Lord Beaconsfield, the British government acquired the Khedive's shares, as well as other interests, in the undertaking, and since British and French capitalists joined in friendly earnestness to make the best of the project, the commercial progress of the canal has had no check. It has been worked for the benefit of all nations. The ships of every country may make use of it on level terms. There is no preferential treatment. The ship of no country can demand as a right immediate passage through the waterway, but all must take their turn.

In the year 1870 there was general satisfaction at the announcement that 500 vessels had traversed the canal during the twelve months. The number in 1912 was 5,373, representing a net tonnage of 20,275,120. Of the total tonnage British ships claimed 63.4 per cent, German 14.9, Dutch 6.1, Austro-Hungarian 4, and French 3.9. The position may be put in another form, thus:

	Vessels.	Tonnage.
British	3,335	12,847,621
German	698	3,025,415
Dutch	343	1,240,264
Austro-Hungarian	248	813,908
French	221	798,822

Although France takes the fifth place for 1912, it is officially stated that when the figures for 1913 are completed she will be found to have advanced to the fourth position in that year.

The relative position of these countries in 1912 and 1911, as represented in percentage of the total tonnage, is as follows:

	1911. Per Cent.	1912. Per Cent.
British	64.0	63.4
German	15.3	14.9
Dutch	5.3	6.1
Austro-Hungarian	3.4	4.0
French	4.5	3.9

INCREASE OF TONNAGE.

A better idea of the general progress made in the usefulness of the canal is obtained, however, from the grand totals of traffic, apart from their relation to different countries. And for this purpose we may go back as far as 1887, and give the number of vessels passing through the canal, and their tonnage, in the year and every fifth succeeding year:

	Vessels.	Tonnage, Net.
1887	3,137	5,903,024
1892	3,559	7,712,029
1897	2,986	7,899,374
1902	3,708	11,248,413
1907	4,267	14,728,434
1912	5,373	20,275,120

It would scarcely be worth mentioning that there is a slight difference between the British registered tonnage and the tonnage adopted by the Suez Canal authorities, as prescribed by the International Commission on Tonnage in 1883, but for the fact that the Suez scale is to be adopted on the Panama Canal.

REDUCED TARIFFS.

Since the canal was opened the dues have undergone many changes, and at times have proved a very troublesome subject, insomuch that at one stage British shipowners strongly protested at the rates levied, and talked of making a new canal. The original authorized tonnage dues were fixed at 10f. (8s) a ton with a surtax of 4f. In 1885 there was a reduction to 9½f. to be still further reduced as the dividends increased. In 1906 the figure was 7¾ per cent, and at the present time it is 6f. 25c. per ton with reduction for ships in ballast.

The dues amounted:

In 1870 to	£200,000
In 1883 to	2,400,000
In 1911 to	5,245,425
In 1912 to	5,320,000

Deducting expenses from these receipts, there remained last year a gross balance of £368,788.

PANAMA CANAL NOT A RIVAL.

Such steady advancement in financial matters finds a natural sequel in the important developments, necessitating large expenditures, which are now taking place. Nor is there fear in official quarters of a check being given to continued advancement by such analogous enterprises as the Panama Canal, just completed and thrown open to traffic. The converse is, in fact, the case. At the last annual meeting of the Suez Canal shareholders in Paris, M. Jounart, the president of the council, ventured the opinion that the Panama Canal would be a complement to the Suez Canal rather than a rival. He prophesied that the opening up of regions in eastern Asia by the American company would create a traffic, some of which would naturally find its way through the Suez Canal. Be that so or not, the Suez Canal would still remain the shortest route from Europe to the Far East.—*London Daily Telegraph.*

Silvering Mirrors*

By Observing Proper Precautions a New Allied Process Yields Excellent Results

THERE is no lack of formulæ for the silvering of glass; but the technical difficulties which require to be overcome in the production of a silver coating of good quality, permanence and adherence are, as a rule, very considerable. Many years' experience with the various recipes has shown that it is an easy matter to obtain perfect silvering on blown glass; but that the difficulties are encountered when dealing with surfaces of polished glass, particularly when these latter are silvered again and again. This is especially the case when the silvered surface is required to reflect satisfactorily from the coated side. Moreover, difficulties are likewise met with in polishing coatings of metallic silver, which are obtained in the chemical way without the required degree of reflective surface. The film of silver is extremely soft, and it is scarcely ever possible to subject it to after-polishing without scratching it. Therefore, it is highly necessary that a process of silvering should be used which yields a highly reflecting surface without any after-treatment or at any rate reduces such after-treatment to the minimum. Modern methods of silvering, especially those with formaldehyde, yield fine, even, and reflective surfaces; but the processes are most unreliable, particularly in the case of surfaces which have been frequently polished. For these they are practically useless, and altogether so when regard has to be paid to the even absorption by the silver film, as when preparing filters for ultra-violet light. Such silver coatings are invariably cloudy, as also are those prepared with Rochelle salt.

In attempts to prepare silver surfaces of satisfactory quality and permanence I have employed a process which I have worked out from the data of Prof. Gehrke in conjunction with Dr. B. Seegert. It is one which is allied to the old Martin process, and, provided that certain precautions are observed, yields excellent results. The method is exceedingly simple to carry out. It does not call for any scrupulous purity of the chemicals, particularly of the caustic alkali and ammonia, while its results, as regards good reflective power, adherence and permanence, are excellent even under unfavorable conditions. Moreover, the cleaning of the glass, when this process is used, is not of such immense importance as it is in others, and there is not the necessity to keep the surface to be silvered under water, thereby increasing the difficulty of manipulation, and at the same time injuring the surface polish. The process in the form in which it is at present used is described below.

CLEANING THE GLASS SURFACE.

Any silver coating previously on the glass is cleaned off with dilute nitric acid with aid of cottonwool. The glass is then rinsed, and any traces of nitric acid removed with weak ammonia. The slightest trace of nitric acid on the surface or edges of the glass gives rise subsequently in the process to the most serious difficulties; e. g., the silver film is liable to undergo partial solution locally. The glass, after this preparation, is dried with a linen cloth, and the cleaning process proper then carried out. This is done very simply as follows: Equal parts of spirit of wine and commercial strong ammonia are mixed together, and enough powdered impalpable precipitated chalk added to form a thick mixture on shaking up. A few drops of this mixture are poured on to the glass, and rubbed over the whole surface quickly and evenly with cottonwool free from grease. Before the mixture has dried off, a second tuft of cottonwool is used with a quick, circular movement to remove the residue of the cleaning mixture, and as soon as the last trace has disappeared further rubbing is discontinued. Long rubbing with cottonwool which has become dry tends to unevenness of the silver deposit. In the above manipulation it is important to use cottonwool which is perfectly free from any trace of fat or grease, and the fingers should be in the same condition, for which purpose they are rubbed over, before commencing the work, with a little of a mixture of spirit and ammonia. The glass surface is now ready for silvering, and should not be dusted, nor, of course, touched. The silvering is best done immediately, or after an hour or so; plates which are kept for a longer time after cleaning are found to silver badly.

PREPARING THE SILVERING MIXTURE.

The silvering solution is prepared from the following two stock solutions:

A.	Silver nitrate.....	30 gm.	1 oz.
	Water.....	900 c.c.	30 oz.
B.	Caustic potash.....	20 gm.	½ oz.—90 gr.
	Water.....	900 c.c.	30 oz.

To prepare the mixture 750 cubic centimeters (26¼ ounces) of solution A is placed in a spacious bottle, and ammonia added to it until it is just decolorized. It is most important to avoid any excess of ammonia. It is best to ascertain the strength of the ammonia, and from this to add straight away nine tenths of the whole, adding the remaining tenth drop by drop, with constant shaking until the exact condition is secured. This colorless solution having been prepared, the whole of solution No. 2 is now added very slowly, with constant shaking in order to avoid the formation of a coarse precipitate. There results a deep brown opalescent liquid, which is constantly shaken while further adding ammonia, drop by drop, until the point is reached at which a bright solution is temporarily obtained. Here also any excess must be carefully guarded against. The solution should be perfectly clear, but without excess of ammonia, and there is now added to it, with constant stirring, the remaining 150 cubic centimeters (5¼ ounces) of solution A, the addition of which produces a strongly opalescent brownish or yellowish liquid, which is at once filtered, and is then ready for use in silvering.

It is inadvisable to make up larger quantities of the silver solution than that given above. After an hour or two small quantities of a black metallic-looking precipitate begins to deposit, first forming as a crust on the surface, and then falling to the bottom. They do not affect the silvering so long as the solution is drawn off free from deposit, and old solutions work just as well as fresh. Experience has, however, shown that the storage of the silver solution is not without danger. In one instance we experienced a somewhat violent explosion of some liters of the mixture, which broke the containing bottle into small fragments. In other cases, where attempts were made to ascertain the properties of the silver solution, it was not found possible to provoke the explosion by artificial means. Even the black precipitate was found non-explosive; but, nevertheless, it is well to observe due care in its use.

As a reducing agent one can use either the usual inverted cane-sugar or grape-sugar solution prepared from pure grape sugar. The inverted cane-sugar solution is prepared as follows:

C.	Lump sugar.....	25 gm.	385 gr.
	Tartaric acid.....	3 gm.	45 gr.

These are dissolved in 250 cubic centimeters (8¾ ounces) of water, and kept at boiling-point for about 10 or 15 minutes until inverted, cooled, and 50 cubic centimeters (1¾ ounces) of alcohol added. The solution is then diluted with water to 500 cubic centimeters (17½ ounces). In place of it, a 5 per cent solution of grape sugar may be used with exactly the same effect.

The quantity of solution of the reducing agent in comparison with the silver solution is of some effect upon the result. If we use 10 parts of silver solution to 1 part of reducing solution, the process proceeds quickly, but the mirror is not of clean bright surface, and the deposit adheres badly. Larger quantities of reducing agent (about 30 per cent of the silver solution) yield the best, most permanent and brightest coatings. If the proportion of reducing agent be made still greater, the silvering then proceeds slowly; the coating is not such a fine surface, but extremely even by transmitted light. This last form of the process is very suitable when making filters for ultra-violet light; but the one given above is the best when silvering glass for use as a reflector.

MANIPULATION IN SILVERING.

The temperature of the silvering mixture is not of very great effect in the process, but the glass to be coated should not be colder than the solution. If it is warmer, all the better. The silvering takes place best when the surface to be coated is flooded with the silvering mixture immediately the latter has been compounded. Placing the surface to be silvered downward gives bad results. It is best to use glass dishes in which the glass to be silvered is simply laid or is fastened to the bottom with two or three bits of wax. The silvering solution must cover the surface to be silvered to the depth of at least 8 millimeters to 10 millimeters (one third to two fifths of an inch).

During the silvering process (which should not be carried out in sunlight) the dish is vigorously rocked continuously. The silvering solution speedily becomes golden yellow in color, and after from 20 seconds to 30 seconds begins to deposit silver. If all has been done correctly, one sees then that the clean surface of the glass first assumes a beautiful sky color, quickly assuming a silver-gray tone and then a metallic surface. The silvering is allowed to proceed with constant rocking, until there deposit on the silvered coating tiny silver nodules of about the size of a pin's head, which grow from second to second, and finally cover the surface with a gray coating resembling leather. But before this point is reached the operation must be instantly stopped. The correct point requires to be learned by experience. Silvering for too short a time gives a coating which is readily injured, while if carried out for too long a time the surface is dirty and of poor reflecting power. The silvering process is stopped by pouring off the solution quickly and cleaning the silvered surface with distilled water, which can be sprinkled over it in a fairly strong stream. The silver adhering to the surface is thus removed as far as possible by sprinkling with distilled water and the plate is then immersed in distilled water, removed without touching the surface, and a large tuft of cottonwool wetted with distilled water carefully used ov r the silvered surface with light but gradually increasing pressure. The cottonwool must on no account be too dry. It will be found after using it for a few minutes that the water is repelled by the silver surface, and as soon as this is the case over the whole of the plate from end to end, the plate is laid film upward on a solid support, and the last traces of water removed by means of a sheet of filter-paper gently applied with the hand. The excellent adherence of the film enables all these operations to be carried out without risk.

After drying off the last traces of water, the surface should be perfectly uniform, and of fine reflecting power. For most purposes it is ready for use without further treatment. As a rule, there is a delicate film of a bluish color adhering to the surface. It appears to consist of finely-divided silver, but is of no disadvantage for most purposes. To remove it, which is necessary only when the silvered surface is to be used from the front, a clean tampon of mocha leather is taken and fastened over a pad of cottonwool. The leather should be absolutely free from grease. After a few passages of the leather across the surface, with fair pressure, the silver coating becomes perfect, and obtains the maximum of reflecting power. It is very seldom that small fractures are produced by this operation, but they are never of such depth that they can be seen in diffused daylight, but are observable only in sunlight.

Mirrors prepared by the above-described process retain their properties in pure air for an astonishing length of time—longer than those prepared by most other processes. They are, of course, extremely sensitive to hydrogen sulphide; but they can be kept protected for months against the action of this gas if they are wrapped in paper impregnated with lead acetate, or stored in a box with the lid covered with lead-acetate paper. When in course of time the mirror becomes tarnished by sulphide vapor, it is best to silver it afresh. It is difficult to clean up the tarnished surface. Mocha leather so used removes a part of the discoloration, but is apt to impair the mirror surface. An attempt to clean up the surface by use of a tuft of wool soaked in potassium cyanide solution was found to have the drawback of dissolving the silver deposits in parts. Dust which falls on the surface can, however, always be removed without danger with the leather.

*In the above article, translated from the current issue of Eder's "Jahrbuch," Prof. A. Miethe gives the working directions for the silvering of glass by a process which, according to his experience, has proved itself trustworthy in yielding mirrors in which the silver coating is not only highly adherent and lasting, but of the maximum reflecting power. We are indebted to the *British Journal of Photography* for the translation.

The Serpek Process for Nitrogen Fixation*

By Samuel A. Tucker

PROCESSES of nitrogen fixation at present divide themselves into two classes—high tension arc fixation, and chemical absorption. With the former we have a long line of brilliant researches, from the early experiments of Cavendish to those of Lord Rayleigh, McDougall and Howles, Moscicki, Guye, Bradley and Lovejoy, Haber, Nernst, etc., and down to the commercial processes of Birkeland and Eyde, Pauling, and Schönherr.

The earliest work in connection with absorption methods seems to have been done by Jacobs in this country and by Frank in Europe, and they both found that by treating barium carbide with nitrogen at a lower temperature than that necessary for its formation in the electric furnace barium cyanide was formed; as a matter of fact the product consisted of a mixture of cyanide and cyanamide. The method used gave neither a uniform product nor a satisfactory yield, because the carbide was not all at the proper temperature, nor was this temperature known, and further the material was not in such a porous state of division that proper absorption could take place.

The substitution of calcium carbide in the Erlwein process[1] was an improvement as regards cheap raw

*Read before the Boston Section of the Society for Chemical Industry.

[1]See Eng. Pat. 16,298 of 1912; this J., 1903, 554.

material, but much the same method was used as for barium and it could not rank as a commercial success. It remained for Frank and Caro[2] to evolve a practical process of absorbing the nitrogen by calcium carbide to form calcium cyanamide as the chief nitrogenous constituent of the product. The calcium carbide has to be ground to a fine powder and then treated at the proper temperature in an atmosphere of pure nitrogen. The chief expenditure of power in this process is, of course, for the manufacture and grinding of the carbide, as the actual absorption of the nitrogen evolves heat and takes but little more energy than is necessary to raise the mass to the reaction temperature. The cyanamide must also be ground, and the absorption process is somewhat slow. The nitrogen must be exceedingly pure and dry with an oxygen content not over a few tenths per cent. In Europe it is prepared by the fractional distillation of liquid air, and in this country air is passed over hot copper. In any case some copper treatment must be carried on, as Linde nitrogen contains far too much oxygen.

This brief review of the Frank process would indicate that it is somewhat complicated, but in spite of this it appears to be successful, as it is now established on a large scale which is constantly extending. One reason for this is to be found in the comparatively low power cost as compared with the high-tension arc system of fixation. Based on the power necessary to make calcium carbide and converting this to form cyanamide, it works out in favor of the Frank process in about the ratio of 3½ to 1.

This method of fixation has been studied further by Bredig,[3] Foerster and Jacoby,[4] etc., with addition agents, and in our own laboratory on lithium[5] and strontium[6] carbides as absorbers of nitrogen.

We now come to the Serpek process, which appears to be very promising. This method consists in heating bauxite and carbon in an atmosphere of nitrogen at a temperature of about 1800 deg. Cent. in a specially designed electric furnace. Serpek first used aluminium carbide[7] for the absorption, in much the same way that calcium carbide was used by Frank, but the carbide requires a high temperature for its formation and would be expensive. He also found that alumina and carbon could be heated directly in nitrogen to form the nitride,[8] but later discovered that the temperature of the reaction was all important,[9] 1850 deg. Cent. being taken as a maximum. Catalytic or addition agents, such as hydrogen chloride and sulphur dioxide, were found advantageous; the impurities occurring in bauxite seem also to facilitate the reaction. Indeed, with pure alumina and carbon a much higher temperature is required than when bauxite is used. The product formed is largely aluminium nitride, AlN, which can be decomposed by caustic soda to form ammonia and sodium aluminate:

$$AlN + 3NaOH = NH_3 + Na_3AlO_3.$$

In conjunction with Henry L. Read,[10] the author has investigated the Serpek process so far as the reaction is concerned and has verified the chief points of importance as to nitrogen content of the product, the temperature relations, and the necessity of using bauxite. The use of catalyst mentioned by Serpek failed to give any advantage. We have only the information furnished by Serpek's patent[11] and by the recent article of J. W. Richards.[12]

From this we learn some mechanical features of the process, which consist in the use of two rotating inclined cylinders one of which is provided with a detachable electric furnace of the resistance type. Bauxite is passed through the upper cylinder and there meets the hot gases from the reaction which are heated both by the electric furnace and also by combustion with air admitted by suitable ports. Before entering the electric furnace, the bauxite is mixed by means of a side hopper with the requisite quantity of carbon, and thus passes to the electric furnace. The temperature here is in the neighborhood of 1800 deg. Cent., and the charge in its passage meets the nitrogen from a producer placed at the lower end of the apparatus. The charge is thus subjected to the action of the nitrogen, in a very advantageous way for its absorption, and after this stage of the process it passes on to a closed receptacle at the bottom.

The mechanical features appear to be well worked out. The continuous nature of the working is a very decided advantage. The use of producer-gas as a source of nitrogen is unquestionably good, because the heat evolved is utilized to some extent in the process itself. But there is the further advantage in the Serpek design so far as heat conservation is concerned, which is seldom found in electric furnace operations, and that is the utilization of the hot gases to preheat the charge and to calcine the raw material. The electric furnace itself might present some complications, but seems to consist of a tubular section with resisters of carbon and with the refractory parts consisting chiefly of aluminium nitride.

The product obtained consists of a gray powder the exact nitride content of which we do not know. In the experiments that we made at Columbia, some of the selected portions contained about 30 per cent of fixed nitrogen, though it cannot be definitely stated that the commercial product would have this nitrogen content. Under suitable conditions of crystallization, the product seems to consist of nearly pure nitride in which there are apparently two different compounds, the blue and brown crystals, the former having something of the appearance of carborundum, the latter brown needle-like crystals. Prof. Luquer, who has kindly examined these crystals, believes them to be the same. Both are strongly double refracting and have the same structure, but have different properties.

The ease with which aluminium or its carbide takes up nitrogen is well shown by the simple experiment of heating a mixture of aluminium powder and charcoal to the reaction temperature in a crucible, when a mixture of aluminium nitride, carbide and oxide is obtained; from such a mixture it is easy to show the decomposition of the nitride into ammonia by the addition of alkali and also to distinguish the crystals of the nitride under the microscope. Weston and Ellis[13] have studied this reaction and have obtained up to 40 per cent of the nitride in this way.

Aluminium nitride as prepared by Serpek is of value not only from its combined nitrogen but also from the valuable by-product of alumina arising from its decomposition. This should be available for the manufacture of aluminium. Without this advantage, the process as one for the fixation of nitrogen would be of doubtful value; the alumina would have to be used over again as raw material after evolving the ammonia, and apart from the complications, alumina in the pure state requires a much higher temperature for nitrogen fixation than bauxite. So much so is this the case that if this were done it is very doubtful if the process could be carried on successfully.

In a recent paper,[14] I have attempted to show how much this production of alumina is concerned with the aluminium industry. If the Serpek process were to be worked on a scale commensurate with the Frank cyanamide process, the production of alumina would actually exceed the present demands of the aluminium industry in raw material to the extent of some 34,000 tons annually. However, there seems little doubt that the Serpek alumina would find a ready market. It is quite impossible to compare the cost of producing fixed nitrogen by the Frank and Serpek processes, because we know very little as to the costs of making cyanamide by the former, and still less as to the cost of the Serpek product. Perhaps the best way of comparing the processes is to contrast the chief points of each, as follows:

FRANK PROCESS.

Favorable.	*Unfavorable.*
Low power costs for nitrogen fixed.	Process discontinuous.
Material can be used directly as fertilizer.	Heat losses at carbide manufacture stage.
	Expensive nitrogen.
	Two rather complicated grinding operations.
	Low nitrogen content in the product.

SERPEK PROCESS.

Favorable.	*Unfavorable.*
Continuous process.	Expensive raw material.
High nitrogen content in product.	Chemical treatment before nitrogen is available as fertilizer.
Heat conserved.	
Valuable by-product.	

From this it would seem that there were decided advantages attached to the Serpek process, but it remains to be seen just how it will work in practice. It is now being tried in France on a large experimental scale.

The Burns from the X-Rays

A somewhat prolonged manipulation of the X-rays occasions too often, alas! very serious accidents that are sometimes fatal. As a means of protection, says the Paris Correspondent of *Chemical News*, it has been considered advisable to use gloves of a special kind absorbing 60, 75 and even 80 per cent of the X-rays. But the hard rays were hardly ever absorbed. Dr. Maxime Menard, head of the service of radiology at the Cochin Hospital, has just devised an efficacious method of protection against the attacks of the X-rays. A special kind of chest or cupboard, composed of three panels, lined inside with a sheet of lead, of which the minimum thickness is 4 millimeters, protects the specialist in radiology. Crookes's tube producer of the Rontgen-rays and the patient who is to undergo the treatment of the radiations are placed inside this cupboard. The protecting gloves are formed of a rubber tissue in which have been incorporated salts of lead and sulphate of baryta. These metallic salts totally absorb the X-rays when in suitable proportion. The thickness of the tissue does not exceed 4 millimeters. The gloves are rather heavy, but they can nevertheless be easily managed. The experiments made by Dr. Menard in the most variable conditions have shown that the protection of the radiologist and his assistants against the X-rays was absolute. The apparatus will soon be described at length in the Scientific American.

The German Bagdad Railway.—France and Germany have concluded satisfactory arrangements in regard to the railroads which are under construction in Asia Minor. The Bagdad Railway becomes a German organization. The lines uniting the railway with the Black Sea will be under the joint administration of France, Germany, Turkey and Russia.

[2] See this J., 1908, 1096.

[3] See Fr. Pat. 382,188 of 1907; this J., 1908, 225.

[4] Foerster Jacoby, Zeit. Electrochem, 1907, 13, 101 (this J., 1907, 423).

[5] Tucker & Moody, Jour. Am. Chem. Soc. 33, 1478.

[6] Tucker & Wang, Trans. 8th Congress App. Chem., Xa, 121.

[7] Fr. Pat. 367,124; this J., 1906, 1096.

[8] *loc. cit.*

[9] Eng. Pat. 7507 of 1909; this J., 1910, 277.

[10] Trans. Am. Electrochem. Soc., 22 (this J., 1912, 1124).

[11] Eng. Pat. 13,086 of 1910; this J., 1911, 421.

[12] Met. and Chem. Eng., 1913, 11, 137.

[13] Weston and Ellis, Trans. Faraday Soc., 4, 60, 1908.

[14] Tucker, "The Relation of Alumina to the Fixation of Nitrogen," Jour. Ind. and Eng. Chem., 5, 191, 1913.

We wish to call attention to the fact that we are in a position to render competent services in every branch of patent or trade-mark work. Our staff is composed of mechanical, electrical and chemical experts, thoroughly trained to prepare and prosecute all patent applications, irrespective of the complex nature of the subject matter involved, or of the specialized, technical, or scientific knowledge required therefor.

We also have associates throughout the world, who assist in the prosecution of patent and trade-mark applications filed in all countries foreign to the United States.

Munn & Co.,
Patent Solicitors,
361 Broadway,
New York, N. Y.

Branch Office:
625 F Street, N. W.,
Washington, D. C.

SCIENTIFIC AMERICAN SUPPLEMENT

Founded 1876

NEW YORK, SATURDAY, FEBRUARY 28, 1914

Published weekly by
Munn & Company, Incorporated, Charles Allen Munn, President
Frederick Converse Beach, Secretary and Treasurer
all at 361 Broadway, New York

Entered at Post Office of New York, N. Y., as Second Class Matter
Copyright 1914 by Munn & Co., Inc.

The Scientific American Publications

Scientific American Supplement (established 1876) per year $5.00
Scientific American (established 1845) " 3.00
American Homes and Gardens " 3.00

The combined subscription rates and rates to foreign countries including Canada, will be furnished upon application

Remit by postal or express money order, bank draft or check

Munn & Co., Inc., 361 Broadway, New York

The purpose of the Supplement is to publish the more important announcements of distinguished technologists, to digest significant articles that appear in European publications, and altogether to reflect the most advanced thought in science and industry throughout the world.

Table of Contents

	PAGE
Life of Building Power Plants.—By C. M. Ripley	130
Giraffes and How They Are Hunted	131
Alloy Steel for Locomotive Parts	132
Optical Marvels in the Antarctic.—8 illustrations	132
The Stability of Aeroplanes	132
Bites of Venomous Serpents and Their Treatment.—By Dr. R. Burnier.—5 illustrations	133
The Industrial Synthesis of Sodium Cyanide.—By Charles Gravier.—3 illustrations	134
The Arms of the Venus of Milo	135
Deterioration and Preservation of Exhumed Antique Objects.—By Prof. F. Rathgen.—11 illustrations	136
Life at Low Temperatures	137
The Industrial Need of Technically Trained Men.—By W. H. Abbott	138
Rare Gases	139
Map of the World to a Scale of One Millionth	139
Chemical Fire Extinguishers	139
Agricultural Motors in the West Indies	139
Relations of Muscular Exercise to Altitude	139
Stereoscopic Pictures of the Moon.—4 illustrations	140
The Shaw Electric Measuring Machine.—By the English Correspondent of the Scientific American.—1 illustration	141
Deepening the Suez Canal	142
Silvering Mirrors	143
The Serpek Process of Nitrogen Fixation.—By Samuel A. Tucker	143
The Burns from the X-Rays	144